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MAINTENANCE OF DIGITAL TRANSMISSION CHANNELS

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

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CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

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SUBJ: MAINTENANCE OF DIGITAL TRANSMISSION CHANNELS

1. PURPOSE. This change decreases the duration of the percent error free seconds (%EFS) test from 24 hours to 4 hours.

2. DISTRIBUTION. This directive is distributed to selected offices and services within Washington headquarters, the FAA Technical Center, and the Mike Monroney Aeronautical Center; to the branch level within the regional Airway Facilities divisions; and all Airway Facilities field offices.

3. DISPOSITION OF TRANSMITTAL. Retain this transmittal.

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David E. Campbell for
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Operational Support

Distribution: A-FAF-0 (MAX); X(AF)-3; ZAF-604 Initiated By: AOS-220

FOREWORD

1. **PURPOSE.** This handbook provides guidance and prescribes technical standards and tolerances, and procedures applicable to the maintenance and inspection of digital transmission channels. This handbook provides operating and maintenance requirements for specific services that provide digital transmission channels, such as the leased interfacility National Airspace System (NAS) communications system (LINCS). It also provides information on special methods and techniques which will enable maintenance personnel to achieve optimum performance from the equipment and transmission services. This information augments information available in instruction books and other handbooks, and complements the latest edition of Order 6000.15, General Maintenance Handbook for Airway Facilities.

2. **DISTRIBUTION.** This directive is distributed to selected offices and services within Washington headquarters, the FAA Technical Center, and the Mike Monroney Aeronautical Center; to the branch level within the regional Airway Facilities divisions; and all Airway Facilities field offices.

3. **MAINTENANCE AND MODIFICATION POLICY.**

a. Order 6000.15, this handbook, and the applicable equipment instruction books shall be consulted and used together by the maintenance technician in all duties and activities for the maintenance of digital lines. The three documents shall be used collectively as the official source of maintenance policy and direction authorized by the Operational Support Service. References in this handbook shall indicate to the user whether this handbook and/or the equipment instruction book shall be consulted for a particular standard, key inspection element or performance parameter, performance check, maintenance task, or maintenance procedure.

b. The latest edition of Order 6032.1, Modifications to Ground Facilities, Systems, and Equipment in the National Airspace System, contains comprehensive policy and direction concerning the development, authorization, implementation, and recording of modifications to facilities, systems, and equipment in commissioned status. It supersedes all instructions published in earlier editions of maintenance technical handbooks and related directives.

4. **RECOMMENDATIONS FOR IMPROVEMENT.** Preaddressed comment sheets are provided at the back of this handbook in accordance with the latest edition of Order 1320.40, Expedited Clearance Procedures for Airway Facilities Maintenance Directives. Users are encouraged to submit recommendations for improvement.

Charles L. Stith

Charles L. Stith
Director, Operational Support Service

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CHAPTER 1. GENERAL INFORMATION AND REQUIREMENTS

1. OBJECTIVE.
The objective of this handbook is to provide the necessary guidance, to be used in conjunction with information available in instruction books and other handbooks, for the proper maintenance and inspection of digital transmission channels.

2. SAFETY.
Personnel should observe all safety precautions when working on equipment. For guidance refer to Order 6000.15, General Maintenance Handbook for Airway Facilities.

3. CERTIFICATION.
There are no certification requirements for leased or FAA-owned lines.

4. REPORTING IRREGULARITIES, INTERRUPTIONS, AND OUTAGES.

a. Test Equipment. Test equipment and tools required to identify system irregularities and perform routine maintenance of digital lines are listed in the latest edition of Order 6200.4, Test Equipment Management Handbook.

b. Reporting to the Serving Company. After being reasonably certain that FAA equipment is not at fault, the Airway Facilities Sector (AFS) manager, or representative, at the monitoring end of the circuit at fault, shall be responsible for reporting the service difficulty. The latest edition of Order 6030.42, Leased Communications Service Outage Reporting, covers common language to be used and expected action to be taken in case of traffic on or outage of leased services. The latest edition of Order 6030.41, Notification Plan for Unscheduled Facility Interruptions and Other Significant Events, and any other regional escalation procedures, covers procedures to be used in the event of unscheduled facility interruptions.

c. Reporting LINCS Channel Outages. The AFS manager or representative shall contact the Microwave Communications Incorporated (MCI) LINCS Program Management Organization (PMO) Network Management Help Desk. The Help Desk provides a single point-of-contact for day-to-day trouble management. The Help Desk is manned 24 hours a day, 7 days a week. This group initiates and tracks requests for corrective action and ensures that escalation notifications are addressed within established time parameters. Additionally, at each FAA Air Route Traffic Control Center (ARTCC), there will be a dedicated MCI senior technician that should be consulted if any problems are detected in the LINCS system. Beyond the Help Desk there are two levels of trouble reporting assistance. The three levels of trouble reporting assistance are described below.

(1) The MCI LINCS PMO Network Management Help Desk: This group fields all user calls and provides first-level trouble reporting assistance.

(2) The MCI LINCS PMO Network Operations element within the LINCS PMO Network Management function: The Help Desk refers troubles or questions it is unable to answer to the Network Operations element.

(3) The MCI LINCS PMO Network Engineering function: If there are questions that cannot be addressed by the Network Operations element, the Help Desk obtains third-level trouble assistance from the Network Engineering function or from the Newbridge technical assistance center (TAC) if the problem is multiplexer related.

5. AIRCRAFT ACCIDENTS.
Among the responsibilities of the System Maintenance Service in the investigation of an aircraft accident are the evaluation and documentation of the technical performance of the facilities that were, or might have been, involved in the accident. This requires that facility operational data be obtained and recorded in the maintenance logs and performance record forms. These recorded data are official documents and may be used by an aircraft accident investigation board in the determination of facility operational status at the time of the accident. To avoid any misinterpretation of the data, the entries shall be

complete, clear, concise, and accurate. Order 8020.11, Aircraft Accidents and Incidents - Notification, Investigation, and Reporting, should be consulted for details. The following must be obtained and recorded for any facilities involved in an aircraft accident.

a. No equipment adjustments are to be made until the as-found readings are recorded and/or after flight check, if required, is accomplished.

b. Check the operating equipment record to ascertain whether there has been a changeover in equipment. If a changeover has occurred, both sets of equipment must be checked.

c. Obtain a hard copy of the chronological history of all alarms and significant system events maintained by the network management system.

d. Check the communications service (only the active circuits involved with the accident/incident) on an end-to-end basis.

6. TROUBLESHOOTING. For leased channels, troubleshooting and repair are responsibilities of the serving company. FAA personnel should be certain that FAA equipment, or interconnecting FAA circuits are not at fault before reporting trouble to the serving company. Refer to Orders 6030.42 and 6030.41.

7. SERVICE SPECIFICATIONS IN EFFECT. The LINCS contract provides several industry-standard channel types required for digital service, ranging from digital data service (DDS) through digital signal level 3 (DS-3). Maintenance of the following LINCS-specific digital lines are included in this handbook:

a. Digital data service (DDS-2.4 thru DDS-64).

b. Fractional DS-1, channelized format (types F-64 thru F-768).

c. Fractional DS-1, bulk format (types FB-64 thru FB-768).

d. 1.544 mb/s, channelized format (type DS-1).

e. 1.544 mb/s, bulk format (type DS-1B).

8. COORDINATION OF MAINTENANCE ACTIVITIES.

Maintenance activities shall be coordinated with operations personnel to preclude interruptions to air-to-ground communications and air traffic navigation and control facilities. Sufficient advance notice shall be given for maintenance activities so that appropriate Notices to Airmen (NOTAM's) can be issued. (For guidance, refer to the latest edition of Order 7210.3, Facility Operation and Administration.)

9.-10. RESERVED.

CHAPTER 2. TECHNICAL CHARACTERISTICS

11. PURPOSE.

Digital lines provide a reliable high-speed transmission medium for FAA applications. This chapter provides technical background of digital lines and a review of digital line test and performance parameters. This chapter also provides a review of digital services provided under LINCS.

Section 1. TECHNICAL BACKGROUND

12. SYSTEM OVERVIEW.

a. Digital transmission systems are composed of digital transmission and reception equipment, transmission medium (i.e. copper lines, radio, fiber) repeaters, and switching equipment. Digital transmission systems are typically characterized by their high reliability and high speed operation.

b. Digital transmission systems transmit only specially conditioned and encoded digital signals over their transmission medium. Analog signals, to be transported over the digital system, must first be converted to digital. For analog signals, the analog waveform is first digitized by an analog-to-digital (A/D) converter which uses a technique called pulse code modulation (PCM). The resulting digital bits of the converted waveform are encoded and sent over the digital transmission line. On the receiving end, the digital signal is converted back to the analog waveform by a digital-to-analog (D/A) converter. Digital signals are transmitted over a digital transmission system in the same way as the analog waveform, except that no A/D or D/A conversion is required.

c. Most digital transmission systems, particularly those used in the FAA, transport data in a full-duplex, synchronous serial format. Transmitted digital data is encoded and sent over the transmission medium (wires, fiber optics or radio) synchronously to the receiving equipment. Received data is decoded using a master clock. The master clock synchronizes both transmission and reception of the digital data on the network. The master clock is encoded into the data bit stream.

d. The basic digital transmission system is commonly identified as digital signal level 1 (DS-1) which consists of twenty-four channels, each having a capacity of 64 kb/s. Individual channels are identified as DS-0. Each DS-1 has the capacity for transmitting 1.544 Mb/s. Using time division multiplexing (TDM), each DS-0 is assigned a time slot, which is then transmitted sequentially. When a DS-1, also known as T-carrier or T1, uses metallic facilities, repeaters are required every 6000 feet. When fiber is used, repeaters are required every 35 miles. Figure 2-1 shows a simplified digital data transmission system.

13. DATA MODULATION. Modulation converts a communication signal from one form to another more appropriate form for transmission over a particular medium between two locations. Unconditioned analog and digital signals are unacceptable for data transfer over standard synchronous digital transmission systems. This section provides a technical overview of conversion processes required to utilize industry-standard digital networks.

a. **Analog Signals.** For analog signals to be transmitted digitally, they must first be converted to digital format. The following is a discussion of the steps required to convert an analog signal to digital, and transmit the signal over a standard digital transmission system.

(1) A telephone or modem, for example, produces a voiceband analog signal that contains energy up to 4000 hertz (Hz). The resulting voiceband signal

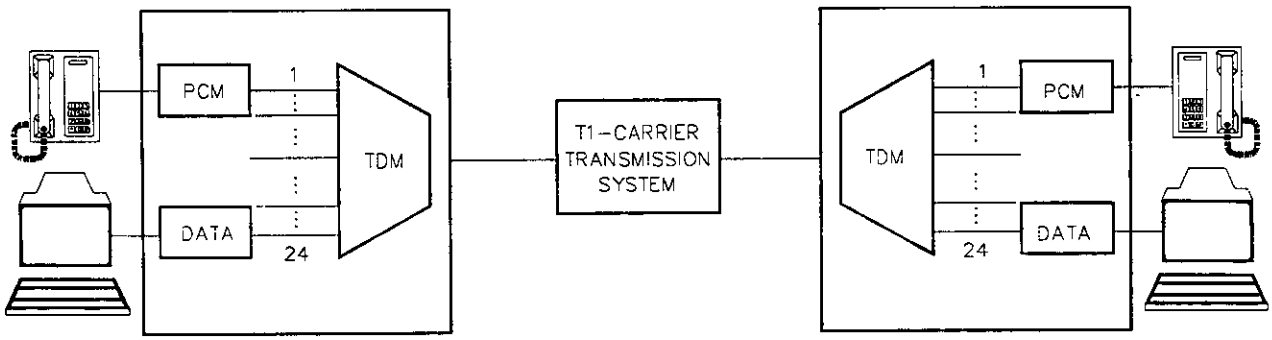


Figure 2-1. Basic Digital Data Transmission

amplitude is sampled at a rate equal to twice the highest frequency present. This rate of sampling, 8000 Hz in this example, is called the Nyquist rate. It has been demonstrated that the minimum sampling frequency required to adequately reproduce the original signal is two times the original signal bandwidth. The resulting signal is an evenly spaced series of pulses that follows the amplitude of the original signal. This signal is called a pulse amplitude modulated (PAM) representation of the original analog signal. See figure 2-2.

(2) Pulse Code Modulation (PCM) is an extension of PAM. Each analog sample value is quantized to a discrete value that is represented as a digital code word. PCM is the most common method of digitizing analog voice signals. PCM is a sampling process that compresses a voice conversation into a 64 kb/s standard rate known as digital signal level zero (DS-0). PCM is a two step technique. In the first step, the incoming analog signal is sampled 8000 times per second, a rate sufficient to adequately represent voice information. These samples are then converted to pulses using the PAM process. In the second step of PCM conversion, the amplitude of each pulse of the PAM signal is quantized to an 8-bit digital pulse stream. The resulting output is a digital representation of the sampled analog waveform. The signal-to-noise ratio can be improved by non-linearly converting the level of the analog signal to digital values. Low-amplitude analog signals are encoded to have a higher degree of resolution to discriminate against low-level noise. Likewise, higher-amplitude PAM signals require less digital resolution because noise levels are proportionally less. The output of the A/D converter is one of 256 possible digital values represented in 8 bits (2^8 = 256). The 8-bit PCM signal is then converted to a serial bit stream for eventual transmission on the digital transmission system. The resulting rate of the bit stream is:

(8000 Hz sampling rate of the PAM signal)
X (8 bits per sample) =
64,000 bits per second
or 64 kb/s.

Figure 2-2 illustrates the PCM coding process.

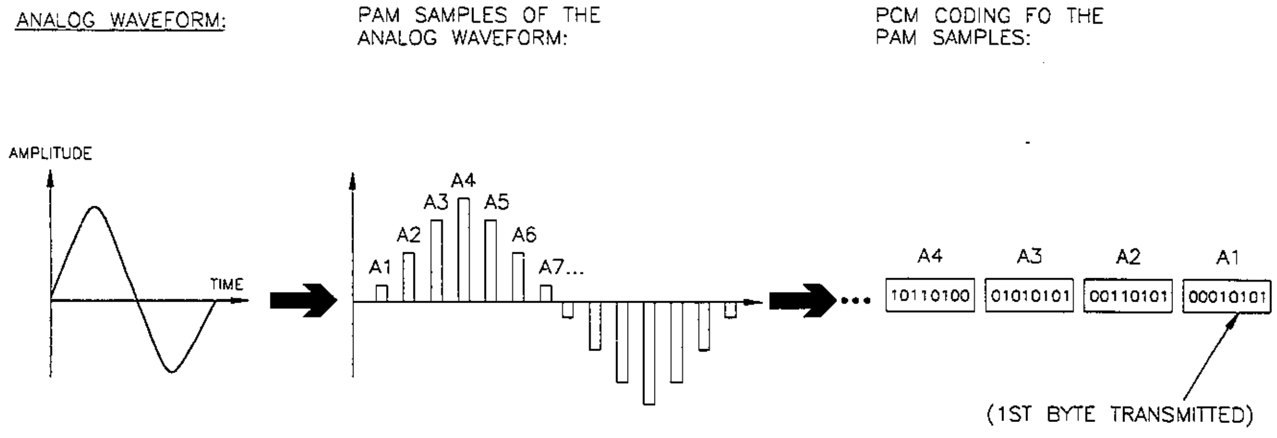


Figure 2-2. Sampling and Quantization

(3) The PCM signal is combined with 23 other signals (either analog or digital in origin) using time division multiplexing (TDM). TDM divides the T1 link into 24 discrete 64 kb/s time slots. An identical number of DS-0 signals (representing 24 separate voice and/or data channels) is assigned to each time slot for transmission within the link. The 24 signals that are time division multiplexed onto a single transmission line utilize the following data rate:

(64-kb/s) X (24 lines) = 1.536 Mb/s.

An additional 8 kb/s is used for framing, error detection and signalling. The resulting industry-standard digital signal rate is 1.544 Mb/s. This is illustrated as follows:

1.536 Mb/s + 8 kb/s = 1.544 Mb/s.

The rate of 1.544 Mb/s is called digital signal level one (DS-1), which is also called a T1 signal. One T1 circuit on normal twisted pair wire carries 24 individual digital signals. On the receiving end, the 24 individual signals are restored to their original analog and/or digital format. This process of conversion, transmission and reception is transparent to the user of the digital transmission system.

b. Digital Signals. Digital signals can be multiplexed directly onto a digital transmission system if they meet the encoding, timing and electrical requirements of the system. In digital transmission over analog lines, the data terminal equipment (DTE) can provide either a synchronous or asynchronous digital output. The DTE is connected over the transmission medium, via a modem, to a compatible data communications equipment (DCE) device for reception. The equivalent of the DCE used in a digital transmission system is called a data service unit/channel service unit (DSU/CSU). The DSU/CSU can be considered a digital modem. The DSU portion of the DSU/CSU converts a standard data interface, such as RS-232, RS-449 or V.35, to a format compatible with digital transmission system timing and framing. See figure 2-3. The CSU portion of the DSU/CSU provides the electrical interface to the digital line, and ultimately the switching network (usually the central office (CO) or local exchange carrier (LEC). If a DTE is compatible with the transmission systems timing and framing, it can be connected directly to the CSU without need of the DSU interface. Likewise, if the DTE is also compatible with the transmission system's electrical interface, it can be connected directly to the digital line. After conversion of the digital signal to the transmission system format, the resulting signal is sent to the CO or LEC for transmission to its destination, or for combination with other digital signals for higher transmission rates.

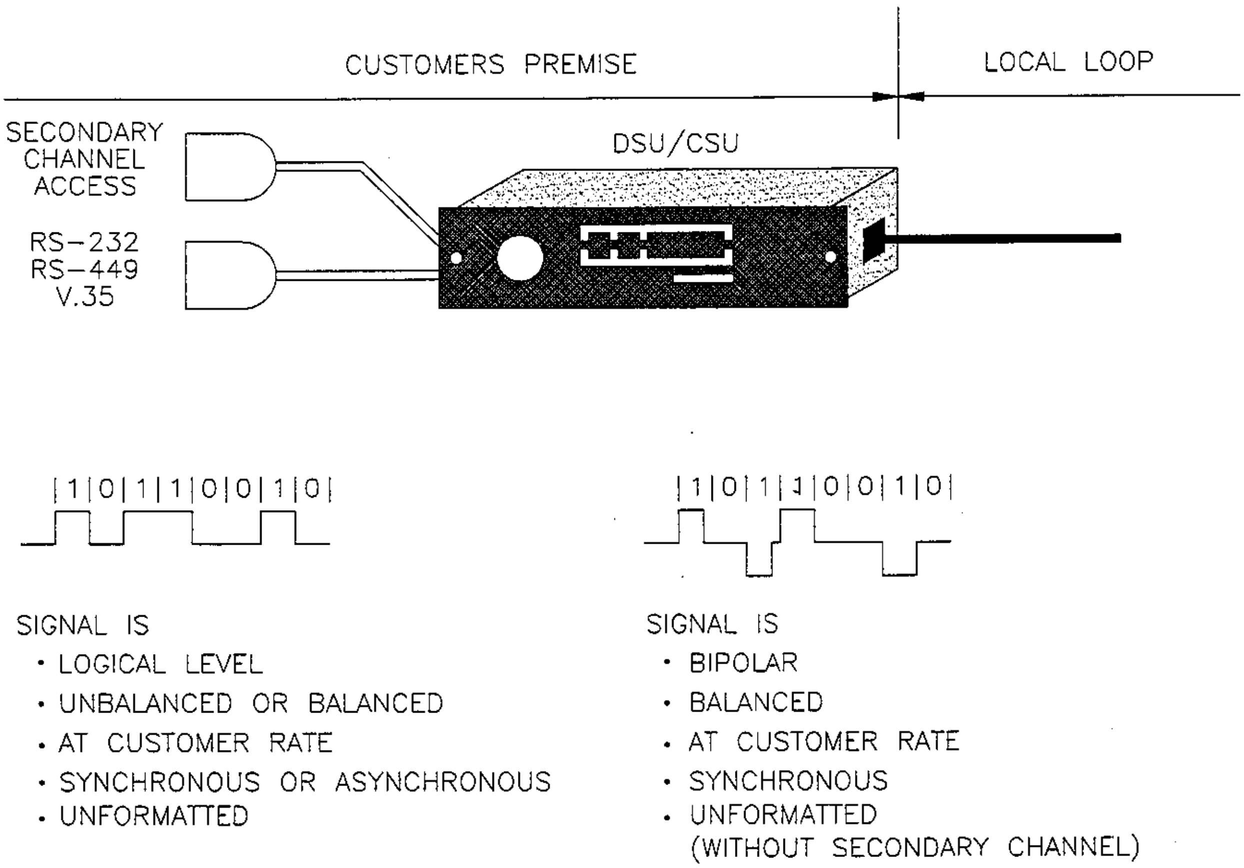


Figure 2-3. DSU/CSU Interface

c. Encoding. A raw binary datastream must be encoded to include electrical and timing information necessary for synchronous data transmission on the transmission system. This subsection identifies different formats used in the encoding of digital data.

(1) Unipolar Data. A digital binary signal, that represent 1's and 0's as a single difference in voltage or current, is called unipolar. Unipolar data is unacceptable for transmission on a digital system because of electrical propagation limitations and the lack of timing information contained in the data. DTE's generally produce a unipolar signal, and must be conditioned for injection onto the transmission system. Figure 2-4 shows a typical unipolar bit stream for reference.

(2) Alternate Mark Inversion (AMI), Bipolar with Eight-Zero Substitution (B8ZS) and Bipolar with Three-Zero Substitution (B3ZS) Coding.

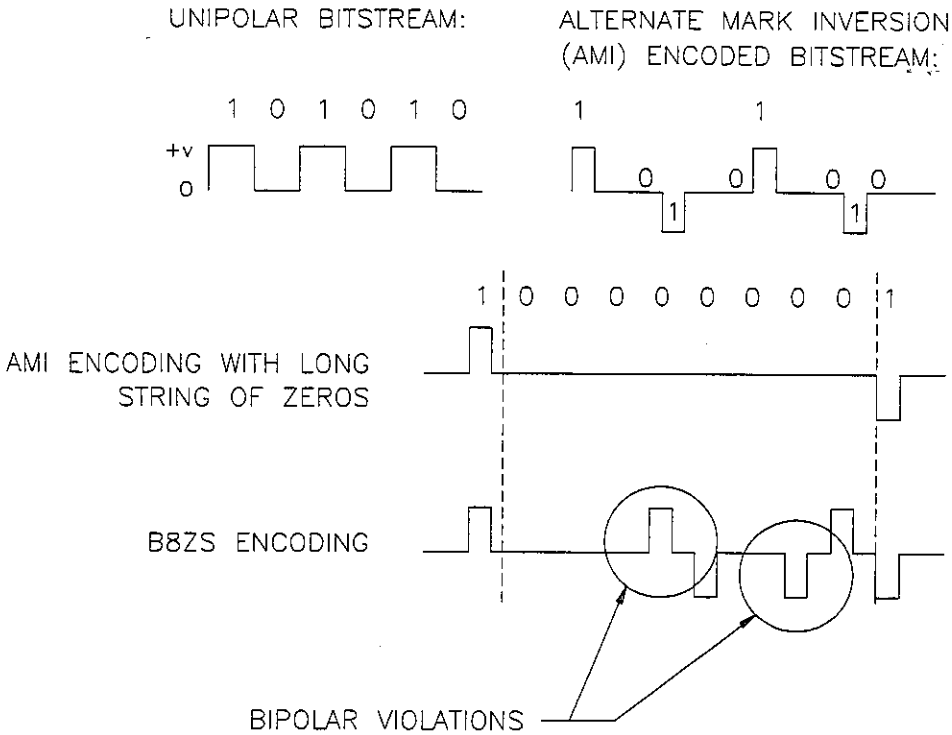


Figure 2-4. Encoding Formats Used in Digital Data Transmission

(a) Conversion of Unipolar to AMI. Unipolar signal bit streams are time-varying digital representations of either voice or data information. Long strings of ones or zeros are represented as dc levels on the line, which cannot propagate on the transmission system. Additionally, the CO uses the digital line itself to provide power to remote repeaters, and dc levels on the line could interfere with power delivery. The unipolar bit stream itself solves part of the problem because, statistically, the number of binary ones should nearly equal the number of binary zeros. There is no way to ensure that the number of binary ones in a signal exactly equals the number of zeros, but there is a way to make sure that every positive pulse is balanced by a negative pulse. AMI encoding is a technique used in digital transmission to address the problem of dc levels on the transmission line. AMI encoding moves the energy content of the passband from near dc (for long strings of either ones or zeros) to the passband of the transmission system. AMI specifies that all zero bits are electrically neutral, and that binary one bits alternate between a positive and a negative polarity. Each binary one bit is the electrical inverse of the next binary one bit. See figure 2-4. AMI encoding is also called bipolar encoding because binary one bits are both positive and negative in polarity. AMI is a synchronous form of digital transmission because timing information is encoded in the bit stream. In AMI, each binary one causes a transition on the line. Each detected transition is used to resynchronize the phase-locked loop (PLL) receive clock, so that synchronous transmission can continue. Without regular resynchronization, the receive clock wanders in phase and frequency, and data is lost.

(b) Clock Synchronization Problems. In AMI, binary zero bits are an electrical null, which contain no clock resynchronization information. This creates a problem for synchronous transmission systems. In most synchronous systems, the digital signals carry timing information so that the receiving equipment can determine when the individual bits begin and end. If the receiver loses synchronization with the transmit signal, the received data becomes unintelligible instantly. With AMI, a long string of zeros represents a period of silence on the line, containing no timing information. A long string of zeros can allow the receive clock to drift sufficiently to cause errors. To avoid lost clock synchronization, digital trans-mission systems require a certain minimum number of ones. Also, since rapid oscillation between positive and negative pulses can also create line noise, there is also maximum number of successive ones that can be transmitted as well. Generally, a signal may contain no group of more than 15 consecutive one bits, and no more than 7 consecutive zeros. The minimum/maximum ones requirement is called ones density. AMI encoding requires that at least one of every eight binary bits be transmitted to provide timing synchronization. In a group of eight binary zero bits, one bit (the least-significant bit (LSB)) is forced to be a one. Therefore, one-eighth of the available 64-kb/s data rate bandwidth (8 kb/s) is used for timing purposes. This leaves 56 kb/s of bandwidth available for data transmission. The use of one bit in eight for timing purposes in AMI is called robbed bit signalling. AMI encoding is often used in voice-only application where loss of a bit does not seriously degrade transmission quality. A modified version of AMI, called B8ZS, is used in FAA applications to achieve the full 64-kb/s clear channel bandwidth requirement.

(c) B8ZS Coding. Bipolar with eight-zero substitution (B8ZS) is an extension of AMI. With B8ZS, deliberate bipolar violations in the DS-1 signal stream are substituted whenever eight consecutive zeros occur. This enhancement avoids the need to alter the PCM stream or the user-produced DS-1 stream to control the ones density and distribution. For data with a run of zeros less than 8, it generates a code identical to AMI. For runs of 8 or more zeros, pulses are forced in the output so that they deliberately violate the normal alternating polarity rules of bipolar encoding. These pulse violations are called bipolar violations (BPV's). The receiving equipment uses the forced BPV sequence to recover the original data, and maintain clock synchronization. B8ZS offers true clear channel bandwidth capability (64 kb/s), that is, the entire bandwidth is available for data transmission. B8ZS is used by many long-distance carriers to provide clear channel service. See figure 2-4.

(d) B3ZS Coding. Bipolar with three-zero substitution (B3ZS) is another extension of AMI and is similar to B8ZS except that for runs of zeros greater than 3, bipolar violations (BPV's) are used to signal the receiving end. B3ZS coding is used in DS-3 (44.736 Mb/s) channel transmission.

14. T-CARRIER CHANNEL CODING METHODS AND ISSUES.

a. Bipolar encoding prepares the DS-1 pulse train for direct application to copper facilities (wire) because it possesses the following desirable properties:

(1) Clocking and sampling need not be absolutely perfect for a bit to be decoded. Also, sampling need not be done exactly at the maximum signal value. For example, any time that a voltage is present, a 1 is read, even if the voltage is below the specified level; if no energy is present, then a zero is read.

(2) Any single-bit error can be detected, which is useful since copper loops are subject to a variety of natural (e.g., lightning) and man-made noises. If an error occurs in a 1-bit position, thereby converting it to a 0, adjacent 1's will be of identical polarity, which is easily detectable, since it violates the polarity rule (BPV). If an error occurs in a 0, converting it to a 1, there will be two successive 1's of identical polarity, which also violates the polarity rule.

(3) This coding method allows a bit error rate better than 10^{-6} 95% of the time, with repeaters spaced about 6000 feet apart.

b. T1 Channels.

(1) A T1 signal (DS-1) is made up of 24 full-bandwidth individual channels, each representing either one PCM voice channel or one digital channel operating a rate of 64 kb/s. A digital channel operating at the 64 kb/s rate is referred to as a digital signal level zero (DS-0) signal. The DS-0 signal may be composed of several subrate digital channels that have been multiplexed together to form one 64-kb/s channel. The product of 24 DS-0 channels times 64 kb/s equals a total data rate of 1.536 Mb/s. The

remaining 8 kb/s of the actual T1 data bandwidth (1.544 Mb/s - 8 kb/s = 1.536 Mb/s) is used for framing and signalling.

(2) The 24 channels of a T1 carrier are multiplexed together and each channel, 1 through 24, is transmitted in turn, whereas, every channel receives a turn before any channel receives a second turn. When a given channel is sampled, a sequence of 8 bits is injected onto the T1 line. The 8-bit sample is called an octet. The sequence of channels repeats itself every 192 bits. A group of 192 bits, or of 24 channel octets, is called a frame. Figure 2-5 shows a conceptual view of how the multiplexing system works.

(3) Framing. The bits in a digital signal are meaningless unless they are organized in an orderly, understandable way. This is accomplished by framing, as depicted in figure 2-5. In order to interpret the 24-channels properly, the receive hardware must distinguish the beginning and end of each frame to establish frame-level synchronization. Depending on the type of framing used, the T1 framing protocol specifies bits in each frame or group of frames as framing bits. When framing information is combined over several frames (usually 12, 24 or more) the resulting frame group is called a superframe. Superframes are commonly used because they reduce the number of overhead bits required to transmit and decode multiplexed information. The following is a discussion of two common frame and superframe protocols used on the T1 network.

(a) D4 Frame. D4 framing uses the 193rd bit from 12 consecutive frames for control and signaling purposes. Over one superframe, the 193rd bits are accumulated to form a 12-bit control/signaling word. D4 framing has improved signal quality over framing techniques that use 1-bit per frame for control and signalling, by freeing more bits for signal use. To enable the sharing of signaling bits by all 12 frames of the superframe, D4 framing uses a process called robbed bit signaling. Robbed bit signaling uses the least significant (8th) bit of the DS-0's 6th and 12th frames for signaling information. The steady state of the bit, 0 or 1, indicates whether the called device is on-hook, off-hook, disconnected, busy, etc. The D4 frame, although still widely used in voice applications, does not support clear channel capabilities required by LINCS and is therefore not used in LINCS applications.

(b) Extended Superframe (ESF). ESF is an extension of the D4 frame. It creates a control word over 24 frames rather than 12, and uses some of the available control word data rate for in-service line monitoring, signaling and link status information. ESF is the required frame format as specified in LINCS. Figure 2-6 shows the format of the extended superframe. A detailed discussion follows.

1 The need to obtain a true measure of system performance without disrupting service spurred the development of the ESF format. ESF expands the superframe from 12 to 24 193-bit frames. Like the D4 format, the 193rd bit in each frame is always a control bit. See figure 2-6.

2 ESF is not merely D4 framing multiplied by two. If that were the case, then all of its 24 control bits (8-kb/s) would be used for frame and signal management. Instead, three-fourths of these bits are reserved for monitoring and evaluation of circuit performance by the carrier.

3 In ESF, 6 control bits are reserved for a cyclic redundancy check called CRC-6. CRC-6 is a method of detecting errors with 98.4 percent accuracy during normal T1 transmission. CRC-6 requires 2 kb/s of data bandwidth. Another 12 bits are reserved as a data link for communication between transmitting and receiving equipment along the T1 link, requiring 4 kb/s. A final 6 bits are used to manage signaling and framing, requiring 2 kb/s. Thus, of the 8 kb/s available between 1.536 Mb/s and 1.544 Mb/s, only 2 kb/s are used for framing.

4 As mentioned above, ESF reserves 12 bits as a data link for communication between the

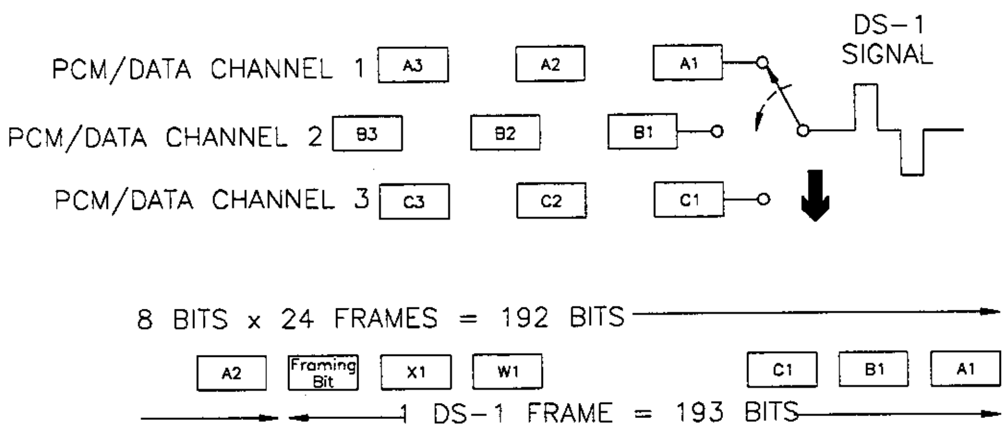


Figure 2-5. Conceptual T1 Multiplexing and Framing

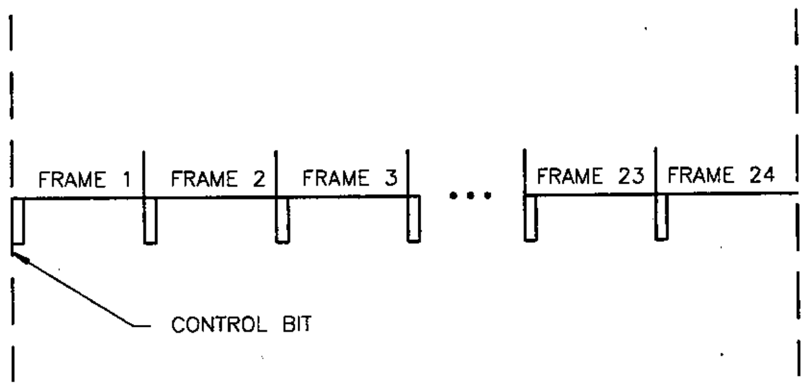


Figure 2-6. The Extended Superframe (ESF) Format

transmitting and receiving equipment on each side of the T1 link. Although the 4 kb/s can be used for any purpose, a typical use is the transmission of trouble flags.

5 In addition to circuit management, ESF also provides enhanced signaling capability. By using the eighth bit from the 6th, 12th, 18th, and 24th frames (signaling bits A, B, C, and D, respectively) in the superframe, more than 16 signaling states can be represented. Enhanced signaling capability is essential for emerging services such as video and equipment monitoring, where signaling states beyond the few used in voice applications may be required.

c. **Repeaters.** Digital repeaters, spaced a maximum of 6000 feet (for copper facilities), regenerate and retransmit the received signal. Regeneration shapes and amplifies the received signal, allowing data transmission to be extended beyond the local CO to the customer premise. Power for repeaters (approximately 100 V dc) is provided over the same wires used for the data transmission.

15. THE DIGITAL HIERARCHY. Individual digitized 64 kb/s channels are referred to as DS-0 signal.

Twenty-four voiceband 64 kb/s channels (DS-0's) are multiplexed to form one DS-1 signal (1.544 Mb/s), also a called a digroup (for digital group). In the U.S., the standardized digital hierarchy uses 1.544 Mb/s for 24 channels, 3.152 Mb/s for 48 channels, 6.312 Mb/s for 96 channels and 44.736 Mb/s for 672 channels. These are called DS-1, DS-1C, DS-2, and DS-3, respectively, but are sometimes referred to as T1, T1C, T2, and T3. See table 2-1.

Table 2-1. THE DIGITAL HIERARCHY (NORTH AMERICAN)

Signal Level	*Digital Bit Rate*	*Equivalent Voice Circuits*	*Carrier System*	*Usual Transmission Medium*
DS-O	64 kb/s	1	None	Wire or Cable
DS-1	1.544 Mb/s	24	T1	Wire or Cable
DS-1C[1]	3.152 Mb/s	48	T1C	Wire or Cable
DS-2[1]	6.312 Mb/s	96	T2	Wire or Cable
DS-3	44.736 Mb/s	672	T3	Microwave, Coax Cable or Fiber Optic

[1] The signal levels denoted are not included in the LINCS specification.

16.-20. RESERVED.

Section 2. DESCRIPTION OF SERVICES

21. PERSPECTIVE. Prior to all-digital transmission, the only practical way to transmit digital information above very low data rates was by conversion to analog, using analog modulation techniques to transfer digital information over an analog transmission system. In a typical analog transmission system the modulated analog signal was sent to the local vendor, where it was converted to digital for transmission over the vendor's digital network. At the receiving end the signal was returned to modulated analog format, and eventually back to digital by the receiving modem. This alternating conversion between analog and digital representations is illustrated in figure 2-7. Digital multiplexing techniques were originally developed as a means of increasing the voice channel capacity of twisted-pair wire. Once the digital techniques were refined and standardized, it was realized that all-digital networks were possible. Digital services were made available to accommodate direct digital-to-digital communications without the need for intermediate analog modulation.

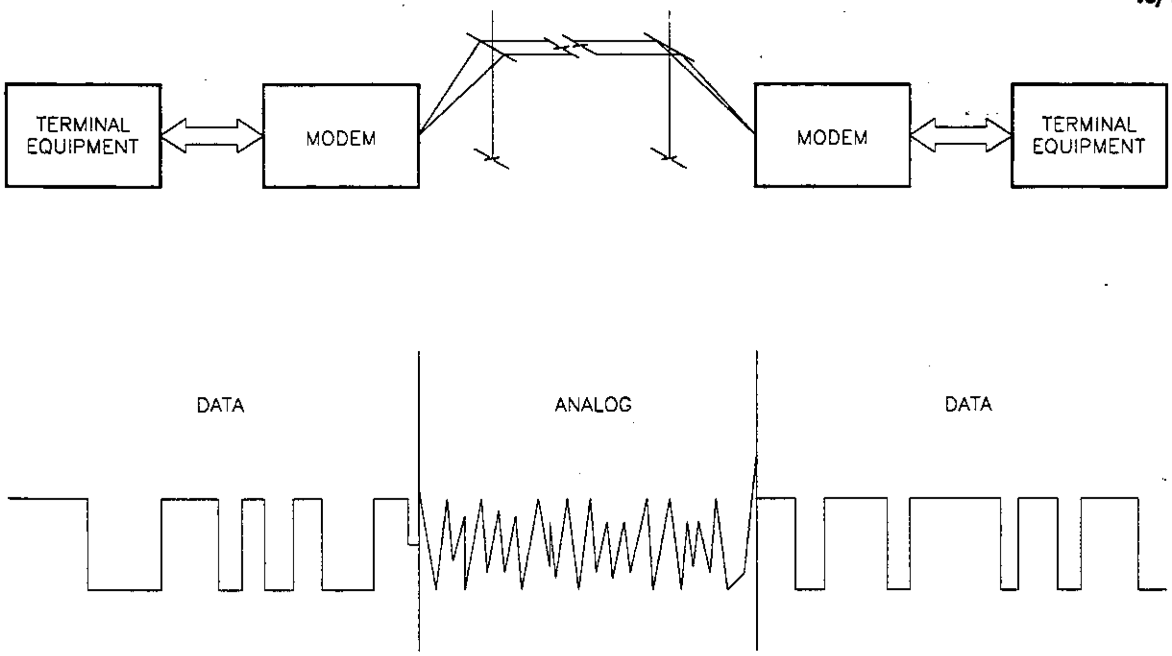


Figure 2-7. Typical Digital-Analog-Digital Transmission

22. DIGITAL TRANSMISSION SERVICES.

a. Digital Data Service (DDS). DDS stands for digital data service. DDS-2.4 through DDS-64 correspond to data rates of 2.4 kb/s through 64 kb/s, respectively. DDS is an all-digital alternative to analog leased lines and modems. DDS is provided in either point-to-point or from one point to multiple locations. DDS is the only U.S. national all-digital service, however there are other local all-digital services available. Figure 2-8 illustrates a typical all-digital DDS network.

(1) Elements of DDS. In DDS and digital transmission in general, the data communications equipment (DCE) is called a data service unit (DSU). The DSU provides either an RS-232, RS-449 or V.35 interface to the data terminal equipment (DTE), just as an analog modem would. The DDS network is synchronous, which means that the DSU supplies a clock, synchronized to the master network clock, to the DTE for data transfer. The DDS local loop provides full-duplex operation with the central office (CO). The DSU is often combined with a channel service unit (CSU), which controls line-access equalization, signal shaping (bipolar encoding), detection of bipolar violations (BPV's) and errors, and provides a loopback path for diagnostics. The CSU is also responsible for providing the B8ZS interface. If the DSU and CSU are combined the resulting equipment is called a DSU/CSU.

(2) DDS Network. DDS uses the digital backbone network between central offices (CO's) to carry digital information directly. The customer's DSU/-CSU is connected to the nearest CO over two-pairs (4 wires) of specially chosen and tested telephone wires, called the local loop, for full-duplex operation. 24 DDS channels are time-division multiplexed (TDM) in a T1 multiplexer to form the T1 signal. There are a wide variety of T1 multiplexers, but the most prevalent is the channel bank multiplexer, called the office channel unit (OCU). The OCU multiplexer is capable of accepting DDS data inputs as well as voice inputs to form the T1 signal. After the DDS signals are combined to form a T1 signal, the signal then passes through the network (sometimes at higher than the T1

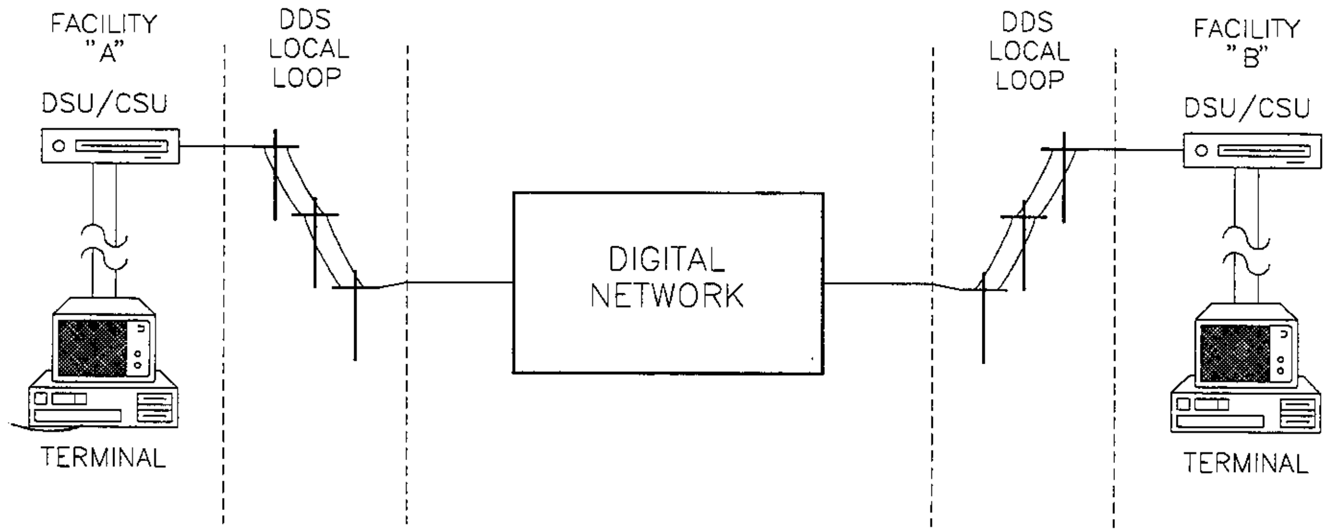


Figure 2-8. Typical All-Digital DDS Network

level if multiple T1 signals are combined) and is demultiplexed in a similar way at the receiving CO. Operation of the network is completely transparent to the user. DDS transmission equipment is similar to digital voice transmission equipment, but also incorporates line monitoring and signaling capabilities designed to reduce errors. Typical figures for line availability and error-free seconds for DDS is greater than 99.9 percent.

(3) Digital Service Areas. CO's are clustered in groups called digital serving areas (DSA's). All the CO's in a DSA connect to one hub office. At the hub office, an individual facility's data is cross-connected to either a CO in the same DSA (and hence to its final destination) or to the hub office in an adjacent DSA. All switching and cross connection takes place at the hub office so that even if the two locations are connected to the same CO, the data between them passes up to the hub office and back again. Switching and cross-connection is transparent to the user.

(4) Signal Characteristics. Various DDS data rates are available, from 2.4 kb/s through 64 kb/s, providing clear-channel operation. The basic 64-kb/s data channel is called a DS-0 channel. Individual DDS channels operating at 2.4, 4.8, 9.6, 19.2 kb/s are called subrate channels of DS-0. A 64-kb/s data stream generated by a single source is called a DS-0A signal. The 64-kb/s data stream generated by several subrate signals multiplexed together is called a DS-0B signal. Distinguishing between DS-0A and DS-0B helps the CO keep track of which signals must be demultiplexed below the DS-0 level as they pass through the network. See figure 2-9.

(5) Secondary Channel. If requested, the digital carrier provides additional data capacity over the local loop to add a secondary channel between the customer and the CO. The additional capacity is operationally

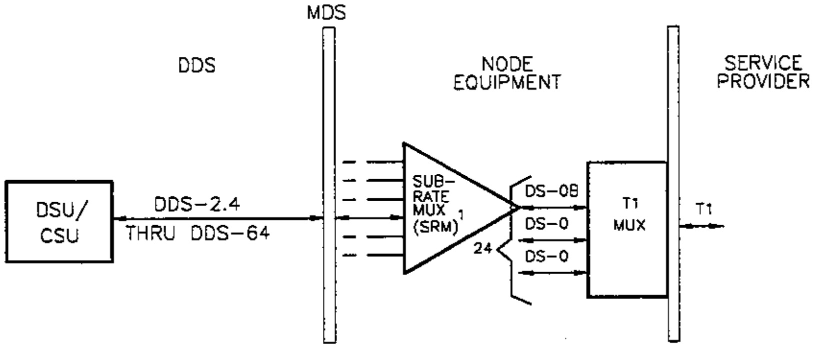


Figure 2-9. DDS Service

independent of the primary channel and can be used for monitoring and control of network equipment, without interruption of normal data transmission. The secondary channel operates over the same two-pair interface as the primary channel. Besides additional data rate requirements, the DSU/CSU and monitored network equipment must support secondary channel operation. That is, the equipment must be capable of responding to the network monitor over the secondary channel. The end-user DSU/CSU multiplexes the primary and secondary channel data, along with any control information, into a single signal for transmission over the local loop to the CO. Secondary channel information is passed through the T1 network to the devices to be monitored. The secondary channel is operated without disruption to normal data transmission. DDS with no secondary channel is called DDS-I. DDS service with a secondary channel is called DDS-II, see table 2-2 for data rate comparisons. See figure 2-10 for illustrated DDS-I and DDS-II services.

Table 2-2. COMPARISON OF DATA RATES FOR DDS-I AND DDS-II SERVICE

DDS-I Local Loop (Primary Channel)	*DDS-II Local Loop (Primary and Secondary Channel)*	*Secondary Channel Data Rate*
2.4 kb/s	3.2 kb/s	133.3 b/s
4.8 kb/s	6.4 kb/s	266.7 b/s
9.6 kb/s	12.8 kb/s	533.3 b/s
19.2 kb/s	25.6 kb/s	1066.7 b/s
56 kb/s	72 kb/s	2666.7 b/s
64 kb/s[1]	N/A	N/A

[1] Primary channel data rate for DDS-I operating at 72 kb/s is 64 kb/s. The additional capacity is used to accommodate overhead bit transfer.

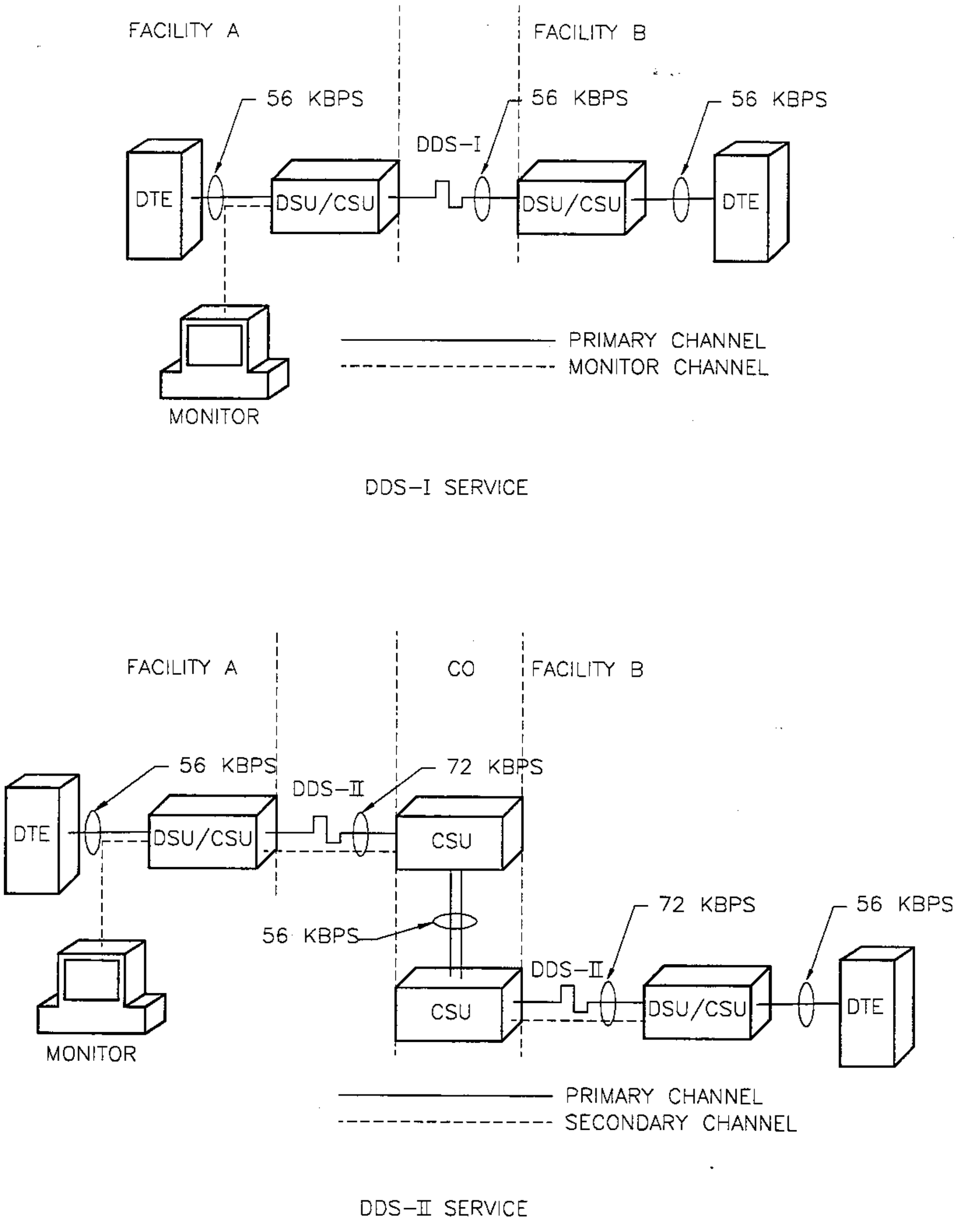
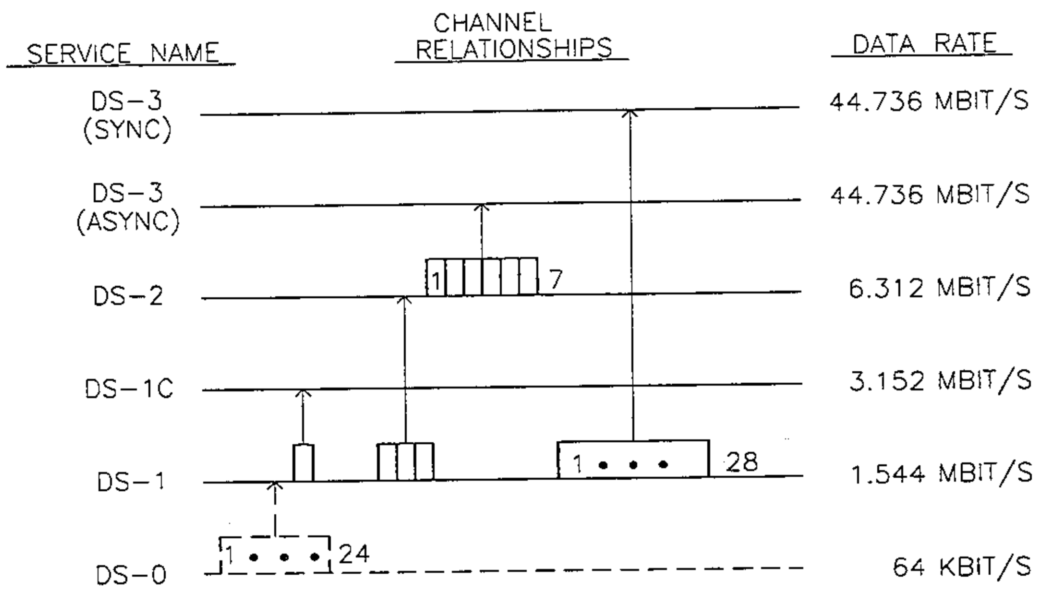


Figure 2-10. DDS-I and DDS-II Services

(6) LINCS DDS Requirements. The LINCS specification identifies six DDS services available for FAA applications. DDS-2.4, DDS-4.8, DDS-9.6, DDS-19.2, DDS-56 and DDS-64 are available for 2.4, 4.8, 9.6, 19.2, 56 and 64 kb/s respective clear channel digital, point-to-point, transmission applications. LINCS specific DDS requirements are identical to industry conventions (see appendix 2), as described above, for primary and secondary channel digital transmission, except where enhanced capabilities apply.

b. T1 Based Services. This section identifies the industry standard T1-based digital hierarchy.

(1) Industry Standard Services. The American National Standards Institute (ANSI) has set forth standards for a hierarchy for digital data transmission in North America (ANSI T1.107-1988). Figure 2-11 shows a partial relationship of various industry standard services and data rates for conventional wire transmission; optical rates and formats are not shown. DS-0 rates (DDS) are not recognized by ANSI, but are included because the service is commonly available. Figure 2-11 shows that a DS-0 channel has a data rate of 64 kb/s, and when 24 DS-0's are combined, they form one DS-1 channel. Figure 2-11 also shows that two DS-1's are required to make one DS-1C channel, and that one DS-3 channel is composed of twenty-eight DS-1's.



DSO IS NOT A FORMAL INTERFACE RATE. IT IS INCLUDED FOR COMPLETENESS BECAUSE IT IS AN IMPORTANT CONSTITUENT OF MANY INTERFACE FORMATS.

THIS FIGURE DOES NOT INCLUDE SPECIFICATIONS FOR THE OPTICAL RATES AND FORMATS.

Figure 2-11. Industry Standard T1-Based Digital Hierarchy

(a) Fractional DS-1. A T1 transmission line comprises 24 DS-0 (64 kb/s) clear channels for a total capacity of 1.544 Mb/s or the total digital bandwidth of 1.544 Mb/s. Fractional T1 (FT1) permits the user to buy DS-0 channels individually, or in bulk bandwidth segments with a total capacity of 1.544 Mb/s. This arrangement provides all the benefits of DS-1 transmission. Aside from the benefits of T1 transmission, FT1 can also provide a viable disaster recover system. The largest FT1 service application is for users who desire more disaster recovery and alternate routing in their networks. FT1 allows users to split up their traffic among different smaller paths. Thus, instead of concentrating traffic over a single T1, for instance, the FAA could purchase two FT1 circuits traversing different routes. The user can route the two FT1 services through two different T-carriers for even more disaster recovery protection; if one carrier point-of-presence (POP) crashes, then the entire network is not at risk.

1 Channelized Format (type F). Type F service provides user access to 1, 2, 4, 6, 8 or 12 clear DS-0 channels (64 kb/s each). 24 DS-0 channels are required for a complete DS-1 channel, therefore the service is called fractional DS-1. Interfacing type F service to the carrier is transparent to the end-user, as access to the service is provided at the master demarcation system (MDS). See figure 2-12.

2 Bulk Format (type FB). Type FB service provides unchannelized bulk digital bandwidth access to the network. Bulk bandwidth is available to the user in groups of 1, 2, 4, 6, 8 or 12 continuous DS-0 channel bandwidths (64, 128, 256, 384, 512, or 768 kb/s). The bulk data rate provided by the carrier corresponds to a continuous group of DS-0 channel digital bandwidths (e.g., if 4 channel bandwidths is required, channels 15 through 18 (384 kb/s) may be provided). Also, bulk channels must be delivered end-to-end in bulk format, and cannot be distributed as individual DS-0 channels. See figure 2-12.

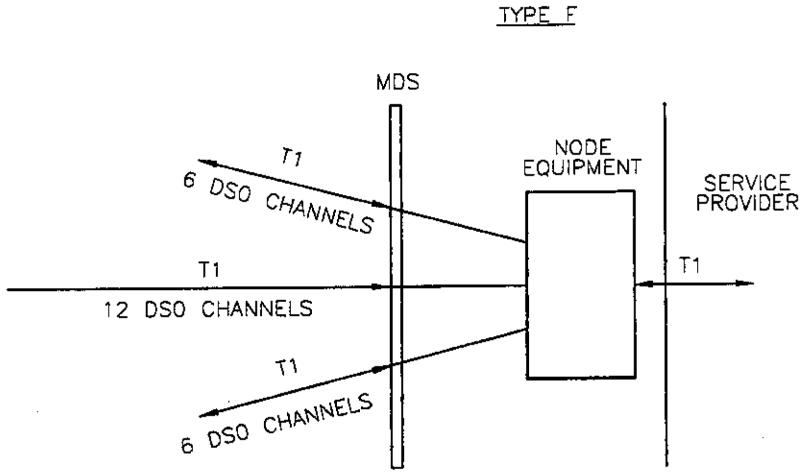
(b) 1.544 Mb/s, Channelized Format (type DS-1). Type DS-1 service provides user access to all 24 individual DS-0 channels of the T1 carrier. Type DS-1 is provided as full T1 service to the facility by the service provider. See figure 2-13.

(c) 1.544 Mb/s, Bulk Format (type DS-1B). Type DS-1B service provides unchannelized bulk access to the T1 network. Bulk access (digital bandwidth) channels must be delivered end-to-end in bulk format; channelization into individual DS-0 channels cannot be provided. See figure 2-13.

(d) 44.736 Mb/s, Channelized Format (type DS-3). Type DS-3 service provides user access to all 28 individual DS-1 or DS-1B channels of the T3 carrier. Type DS-3 can be provided as either the full T3 service or as 28 separate T1 services.

(e) LINCS T1-Based Services. The LINCS specification identifies five T1-based services for FAA applications. Type F, type FB, DS-1, DS-1B and DS-3 are available for clear channel digital, point-to-point, applications. LINCS specific T1-based requirements are identical to industry standards for primary and secondary channel digital transmission, except where enhanced capabilities apply.

c. Typical End-to-End Application. Figure 2-14 illustrates a typical end-to-end application. It shows how a DDS-2.4 signal might be combined with other signals to travel through a typical digital network configuration.



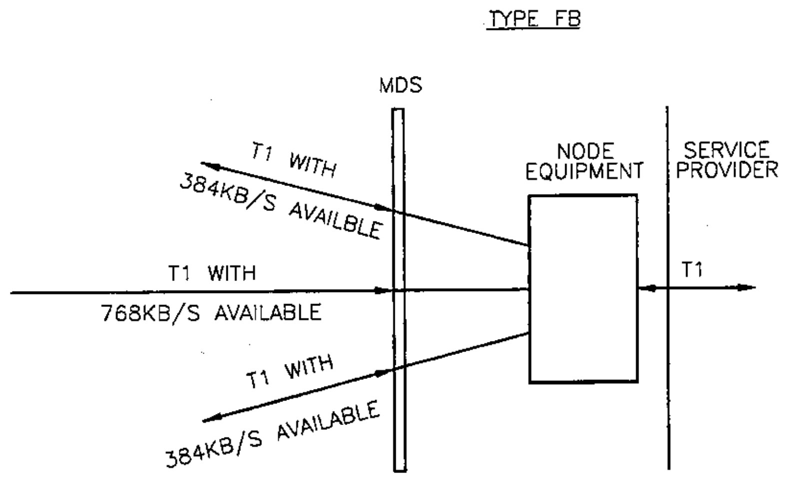


Figure 2-12. Typical Type F and FB Services

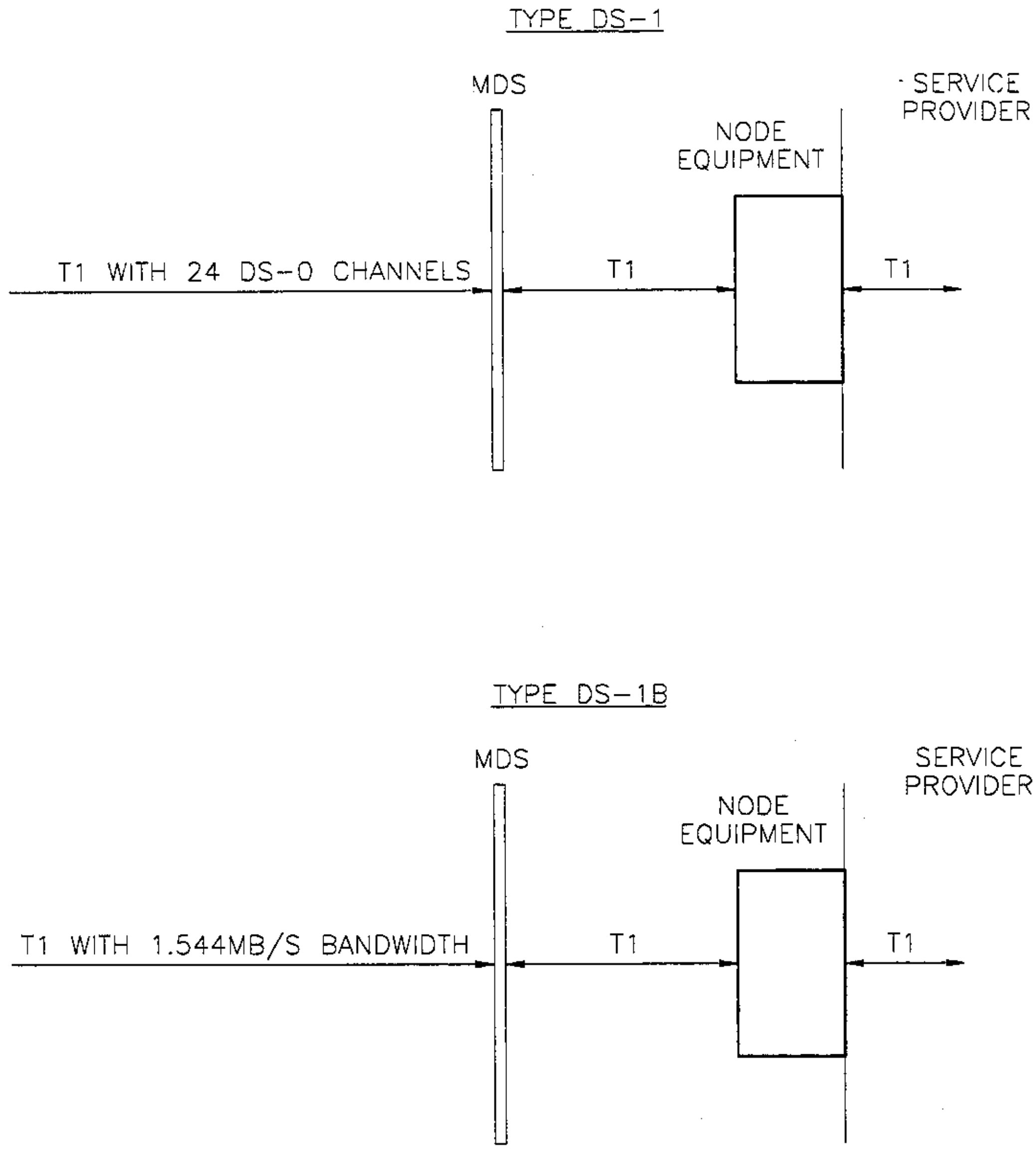


Figure 2-13. Typical Type DS-1 and DS-1B Services

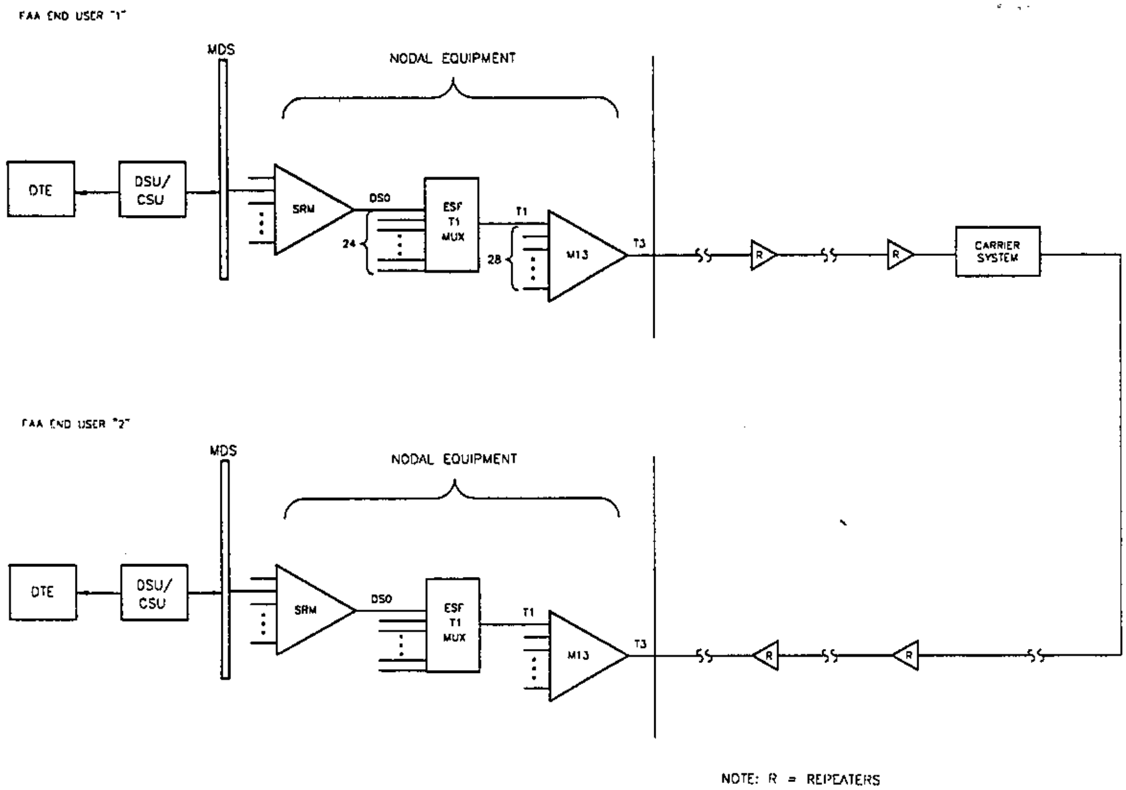


Figure 2-14. Possible End-to-End Application for DDS

23.-30. RESERVED.

Section 3. DIGITAL PERFORMANCE AND TEST PARAMETERS

31. DIGITAL MAINTENANCE. Although the availability of all-digital networks approaches 100 percent, errors occur. In general, the digital transmission channel is either operating normally, operating with poor transmission quality, or the channel is completely down. The maintenance of digital systems involves the identification and monitoring of specific key performance parameters for degradation trends. Digital channels are monitored to identify statistical degradation over time, to help avoid channel outages. Digital channels are also monitored so that monetary compensation can be provided by the carrier if the channel does not comply with system performance specifications. The following is a discussion of digital performance and test parameters pertaining to both operational channel monitoring (in-service monitoring), or when a channel must be taken off-line for maintenance (out-of-service monitoring and testing).

a. Aggregate Speed. Refers to the total data rate of the data channel, combining both primary and secondary channel rates.

b. Bipolar Violations (BPV's). A bipolar violation occurs when a logic 1 bit is received that is not opposite polarity of the preceding logic 1 bit. Noise and crosstalk can affect the bipolar signal to the point where a no-pulse condition is interpreted as a pulse condition. The resulting BPV can be counted. When the BPV rate is high, it is generally indicative of some intrinsic problem. An instrument that measures this data can, therefore, be useful in isolating the problem. It should be noted that the B8ZS method employed to achieve clear channel conditions uses deliberate violations. The BPV's are used in ESF framing to increase the data rate of the channel by providing clear channel capability. These intentional violations must not be counted as errors, so the test equipment for B8ZS lines must be appropriately configured. BPV's can also be used to transfer control codes over the channel, if the receiving equipment is designed to interpret them. BPV's can be measured in-service, but provide an estimate to the bit-error rate that is only about 50% accurate. See figure 2-15.

c. Errored Seconds (ES). A one-second period of data transmission with one or more errors. The definition of an error depends upon the data rate; for DDS an error is a bit error, for DS-1 and DS-3 errors are measured by the CRC error rate. A basis for the measure of line quality.

d. Severely Errored Seconds (SES). A one-second period of data transmission with an error count or rate above a specified threshold. The error threshold depends on the data rate: for DDS the error threshold is a bit error rate (BER) worse than 10^{-3}; for DS-1 services the error threshold is 150 or more ESF error events and/or an out-of-frame (OOF) state; for DS-3 the error threshold is 4000 CRC-9 error events and/or an OOF state.

e. Bit-Error Rate (BER). Ratio of incorrect bits detected to total bits received. Useful for detecting error bursts over specific bit intervals. Bit errors are counts of bits whose logical state has changed along the transmission path. A basic measurement for judging circuit quality and availability.

f. Consecutively Severely Errored Seconds (CSES). The number of continuous one-second intervals in which a specific number of severely errored seconds (SES) have occurred.

g. Error Free Seconds (EFS). Any one-second interval in which no bit errors occur. The percentage of error free seconds is a measure of circuit quality, usually measured with respect to a 24 hour period.

h. Line Availability. Availability is a key performance measure for digital services. For maintenance purposes, a service is considered available when the BER is less than 10^{-6}. Different levels of availability are guaranteed under LINCS for different services. In general, a service is considered available, under LINCS, if ten consecutive seconds of data are received with no SES. Refer to the definition of SES in paragraph 31d, above.

i. Phase Jitter. Phase jitter is a timing impairment that in large amounts can lead to error bursts or timing slips. Jitter measurements, like excess zeros detection, are particularly useful when performed on in-service circuits. Live traffic may cause pattern-dependent jitter not observable when controlled patterns are applied. It should be noted that some T1 switching equipment effectively removes jitter, just as they remove bipolar violations. Whether provided by the network or by the user equipment, timing must be within 50 parts per million (80 Hz at DS-1 rates). Operation outside this range will result in jitter that, in turn, implies timing slips and data errors. Jitter is a short term (phase oscillations of frequency greater than 10 Hertz) displacement in time of a signal transition, as compared to the ideal signal transition. The severity of the distortion depends on both the amplitude and frequency of the displacements. Predominant sources of jitter are multiplexers and regenerative repeaters. See figure 2-15.

j. Phase Wander. Phase wander is identical to phase jitter except that phase wander is a long term (phase oscillations of frequency less than 10 Hertz) displacement in time of a signal transition, as compared to the ideal signal transition.

k. Framing Errors. Framing errors occur when the receiving equipment or a repeater is incapable of recovering the clock. This condition can be caused by a number of system impairments. Repeaters in DS-1 lines require a specific density of one bits to maintain synchronism. Excess zeros can cause repeaters to shut down and put the facility out of service. Framing information is sent as 1 bit out of every 193 bits, giving a framing pattern that can be checked for errors. Loss of synchronism leads to framing errors, where an incorrect bit appears in the framing position (193rd bit). The incorrect framing word of 12 bits precludes correct decoding of the subchannels. Unlike the BPV rate, framing errors closely approximate the actual T1 error rate even for high error rates. Framing error analysis is a powerful tool for measuring the end-to-end performance of a T1 circuit. Framing error analysis covers only that portion of the T1 circuit from the point of measurement back to where the T1 signal is reframed (e.g. the local loop). See figure 2-15.

l. Cyclic Redundancy Checking (CRC) Errors. ESF framing includes a CRC-6 multi-frame check sum which is used for in-service performance monitoring. Tests are based on a CRC code embedded in the bit stream formed by the accumulation of the 193rd bit. The CRC can provide measurement of the line's quality. Switching and cross connection destroy its validity for end-to-end testing. End-to-end CRC-6 error performance monitoring is valid, however, for testing of unswitched private-line T1 services. CRC's can be measured in-service, and provide an estimate of the bit-error rate with about 98% accuracy. See figure 2-15.

m. Timing Slips. Excessive jitter, frequency offsets, or the improper selection of the timing source to the facility can result in timing slips. A slip occurs when a data receive buffer overflows or underflows, or when a device can no longer properly recover the T1 signal and one or more data bits get added to or deleted from the T1 signal. Timing slips are classified as either controlled or uncontrolled slips. Data bits are added or deleted for either type of slip. The difference between controlled and uncontrolled slips lies in whether the framing information remains in the correct time slot. For example, if a central office's input buffer overflows, data bits are deleted from the outgoing T1 signal while the framing remains intact; this is an example of a controlled slip. If, on the other hand, a DSU/CSU input buffer overflows, data bits are deleted from the outgoing T1 signal and framing information is shifted by the number of data bits deleted; this is an example of an uncontrolled slip. Uncontrolled slips can be identified through frame losses. If frame losses occur with no accompanying bit errors or bipolar violations, the frame loss (error) more likely occurred due to a timing slip and not because of a burst of errors. Controlled slips can be identified by observing the received data pattern and identifying clock (or timing) slips. See figure 2-15.

n. Data Carrier Detect (DCD) On/Off. The DCD signal is measured for a prescribed number of seconds and compared against a specified value. The DSU/-CSU then looks for either the presence or absence of data transfer from the DTE. Although this parameter is not directly associated with the digital data line, it is often monitored because it reveals the level of activity on the data channel and can be used for trouble-shooting.

o. All-Ones Condition. All-ones signal patterns are transmitted to keep the repeaters synchronized even when no real data is being transmitted. Detection of this alarm condition indicates a failure of some network component.

p. Delay. Measure of round trip transmission delay. Useful for detecting possible cause of protocol time-outs.

q. Out-of-Service Testing. Several parameters of digital transmission can only be measured by taking a line out of service. Out-of-service testing can be done on a point-to-point basis, or by creating a loopback. Point-to-point testing requires test equipment at both ends of the data link. Test patterns are sent on one end of the link and data errors are analyzed at the other end. Loopback testing requires only one piece of test equipment. In loopback testing, the test equipment sends a code to the distant CSU telling it to go into loopback mode. The test equipment sends data, and analyzes the receive data for errors. Figure 2-16 illustrates both point-to-point and loopback testing.

r. In-Service Monitoring Of Live Data.

(1) Monitoring with Standard Test Equipment. The in-service method allows live data to be monitored at various access points without disturbing traffic.

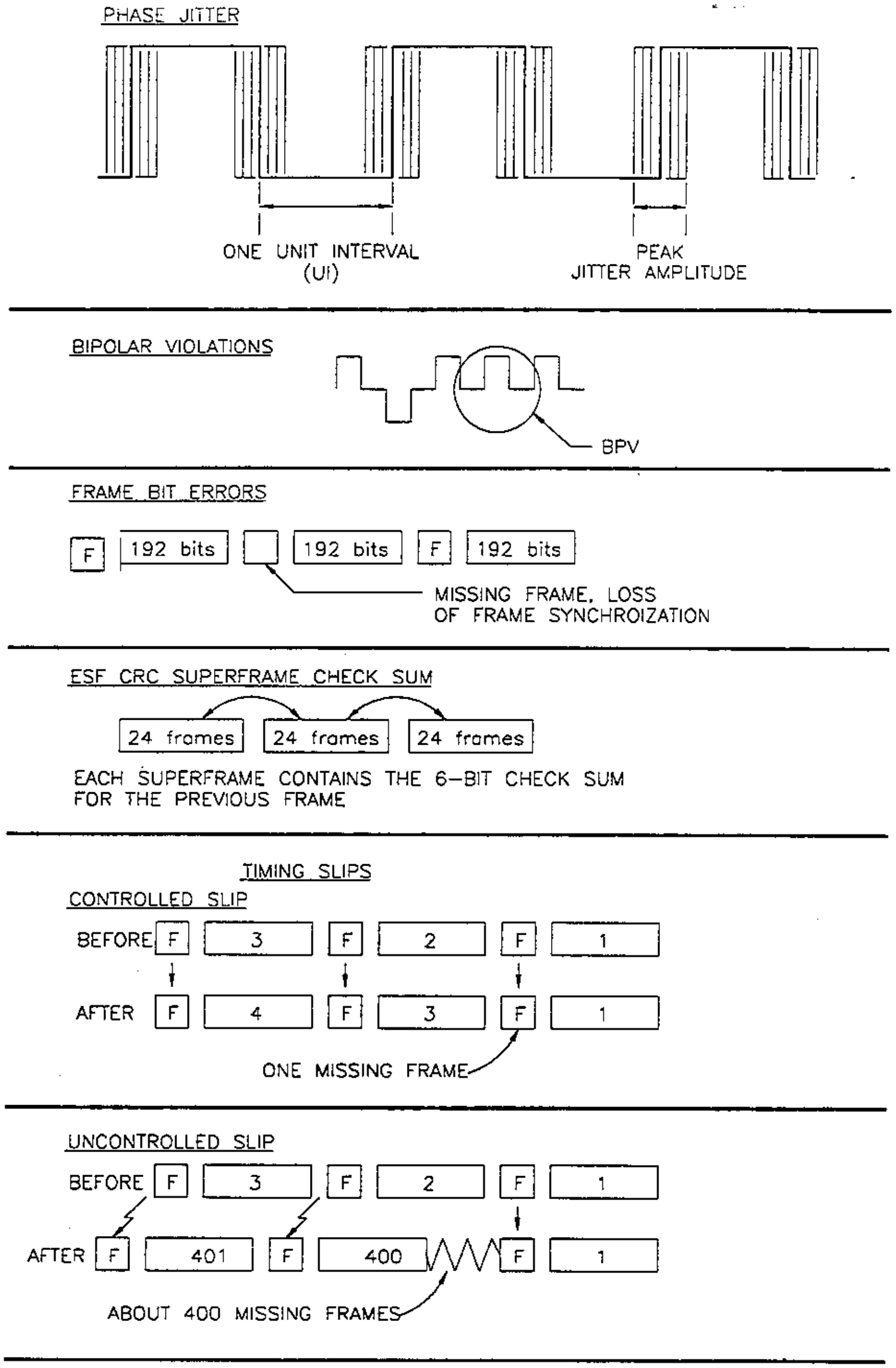


Figure 2-15. In-Service Digital Data Performance Parameters

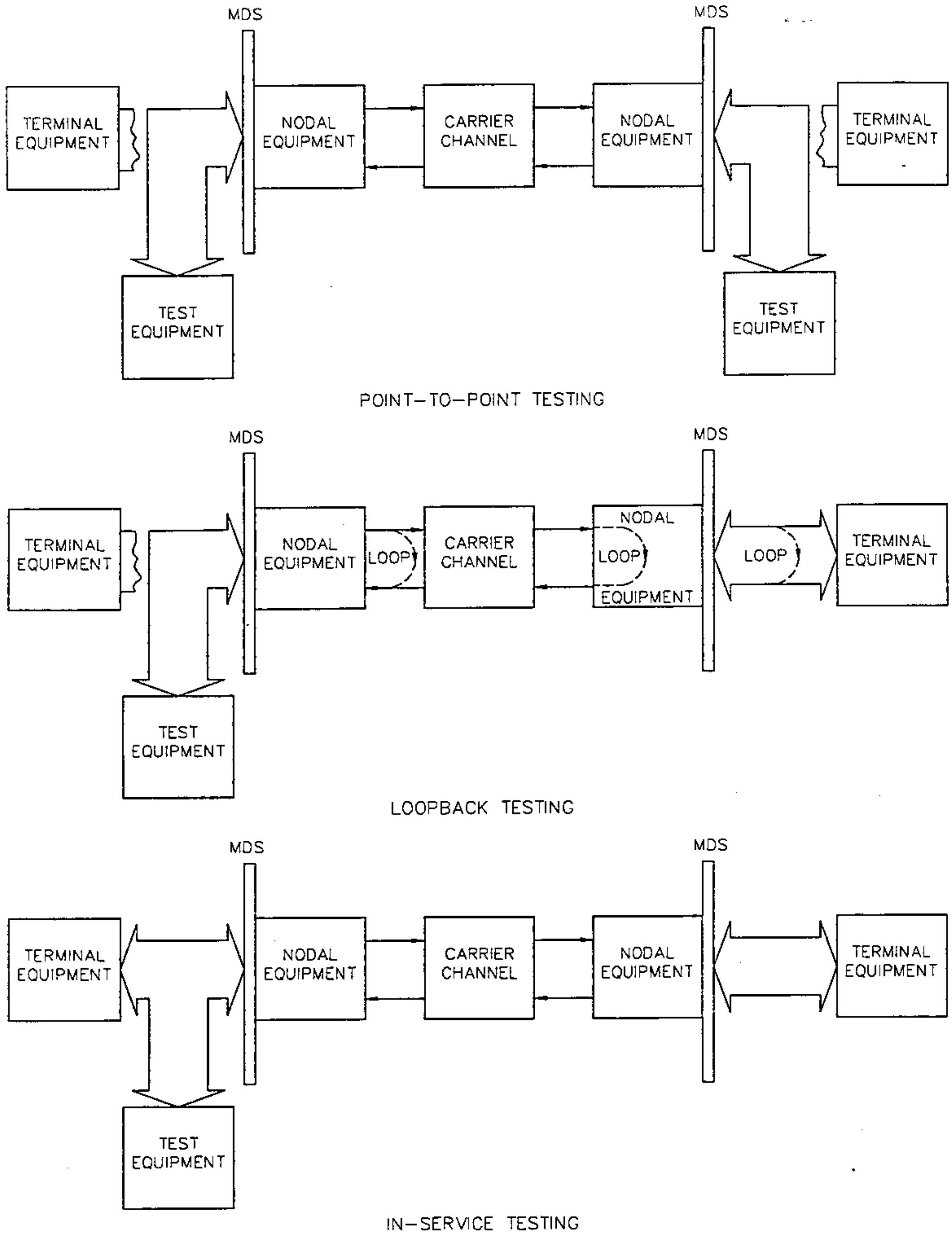


Figure 2-16. Typical In-Service and Out-of-Service Testing

Since in-service monitoring does not disrupt the transmission of live traffic, it is more suitable for routine monitoring than out-of-service testing. Additionally, in-service monitoring indicates performance under actual operating conditions. But its primary disadvantage is that its measurements may not be as precise as those available in out-of-service testing. Also, some network equipment may deter in-service measuring. See figure 2-16.

(2) Monitoring with the Newbridge 4602. The status of all LINCS circuits (including digital lines) is monitored on a real-time basis using the Newbridge 4602 Network Management System (NMS), located at MCI. A Newbridge 4602 view only workstation is installed at FAA designated locations. It provides status reporting on configurations, degradations, and failures for all nodes, paths, channels and end user locations. These workstations provide monitor-and-display capabilities only, and do not support network configuration changes, or commands to initiate diagnostic tests. The focus of the view-only is its network map, which graphically depicts the configuration of the LINCS network elements and uses color to indicate their operational status. When the performance of a network element falls below required thresholds, and therefore declared unavailable, the system status display automatically updates the displays' presentations (change in icon color) to reflect current status. The operator is automatically presented with a graphic display of the network configuration using different icons to represent end user location A (EUL-A) multiplexer nodes, EUL-B channel banks, backbone transmission paths, and individual user channels. Successive levels of graphic detail are provided as the operator zooms in on an icon. Within the equipment at EUL sites, individual cards or modules can be displayed. All configuration icons are color coded to display status: normal operation, degraded performance, service failure (unavailable), or out-of-service to maintenance (unavailable). Changes in color correspond to changes in network element status. A typical configuration of the 4602 display system is shown in figure 2-17.

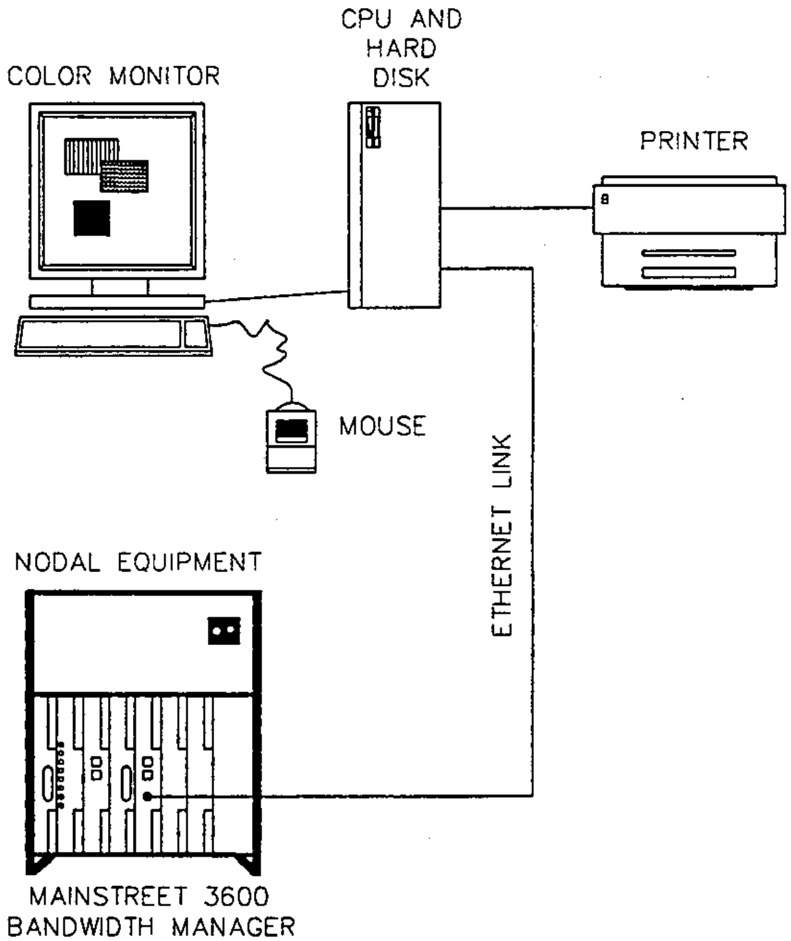


Figure 2-17. 4602 NMS View Only Monitoring System

32.-35. RESERVED.

CHAPTER 3. STANDARDS AND TOLERANCES

36. GENERAL. This chapter prescribes the standards and tolerances for leased digital private line circuits. All key performance parameters and/or key inspection elements are clearly identified by an arrow (→) placed to the left of the applicable item.

37. NOTES AND CONDITIONS. The following describe the requirements, variances, or test limits to be considered when applying the values listed in the standards and tolerances.

a. Channel Types. Technical requirements for LINCS channels are provided in Appendix 2, LINCS Interface Requirements. Additional channel types and modifications to existing channel types provided as industry standards mature and FAA requirements mandate their use. Examples of these channel types include channels which provide Integrated Services Digital Network (ISDN) capability, and which comply with the FAA Open Systems Interconnection Profile (GOSIP). Leased digital channels are provided in the following types; DSU/CSU's are not included, and must be supplied by the user:

(1) Type DDS (Digital Data Service)

(a) DDS-2.4 (2.4 kb/s)

(b) DDS-4.8 (4.8 kb/s)

(c) DDS-9.6 (9.6 kb/s)

(d) DDS-19.2 (19.2 kb/s)

(e) DDS-56 (56 kb/s)

(f) DDS-64 (64 kb/s)

(2) Type F (Fractional DS-1, Channelized Format)

(a) F-64 (1 DS-0 Channels)

(b) F-128 (2 DS-0 Channels)

(c) F-256 (4 DS-0 Channels)

(d) F-384 (6 DS-0 Channels)

(e) F-512 (8 DS-0 Channels)

(f) F-768 (12 DS-0 Channels)

(3) Type FB (Fractional DS-1, Bulk Format)

(a) FB-64 (64 kb/s)

(b) FB-128 (128 kb/s)

(c) FB-256 (256 kb/s)

(d) FB-384 (384 kb/s)

(e) FB-512 (512 kb/s)

(f) FB-768 (768 kb/s)

(4) Type DS-1 (1.544 mb/s, Channelized Format)

(5) Type DS-1B (1.544 mb/s, Bulk Format)

(6) Type DS-3 (44.736 mb/s, Channelized Format)

b. Reserved.

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
38. LINCS DIGITAL DATA SERVICE (DDS). DDS-2.4, -4.8, -9.6, -19.2, -56, AND -64.				
→ **a. Signal level**				
(1) Transmit	92	0 dBdsx	±1 dBdsx	Same as initial
(2) Receive	92	0 dBdsx	±1 dBdsx	Same as initial
b. Simplex current				
(1) Minimum	92	4 mA	Same as standard	Same as initial
(2) Maximum	92	20 mA	Same as standard	Same as initial
→ **c. Errored seconds**	92	5 or less in 1 hour	Same as standard	Same as initial
d. Percent error free seconds (% EFS)	92	<1000 miles: ≥99.96% in 24 hours	Same as standard	Same as initial
		1001-2000 miles: ≥99.94% in 24 hours	Same as standard	Same as initial
		>2000 miles: ≥99.9% in 24 hours	Same as standard	Same as initial
39. LINCS TYPE F (FRACTIONAL DS-1, CHANNELIZED FORMAT). F-64 (1 DS-0 CHANNEL) F-128 (2 DS-0 CHANNELS) F-256 (4 DS-0 CHANNELS) F-384 (6 DS-0 CHANNELS) F-512 (8 DS-0 CHANNELS) F-768 (12 DS-0 CHANNELS)				
→ **a. T1 signal level**				
(1) Transmit				
(a) dBdsx	93	0 dBdsx	±2 dBdsx	Same as initial
(b) Voltage	93	3 volts peak	±0.6 volts	Same as initial
(2) Receive				
(a) dBdsx	93	0 dBdsx	±2 dBdsx	Same as initial
(b) Voltage	93	3 volts peak	±0.6 volts	Same as initial
b. T1 simplex current				
(1) Minimum	93	60 mA	Same as standard	Same as initial
(2) Maximum	93	140 mA	Same as standard	Same as initial
→ **c. T1 pulse mask**	94	Within template	Same as standard	Same as initial
→ **d. Errored seconds**	93	5 or less in 1 hour	Same as standard	Same as initial

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
e. Percent error free seconds (% EFS)	93	<2000 miles: ≥99.9% in 24 hours	Same as standard	Same as initial
		>2000 miles: ≥99.85% in 24 hours	Same as standard	Same as initial
40. LINCS TYPE FB (FRACTIONAL DS-1, BULK FORMAT). FB-64 (1 DS-0 CHANNEL) FB-128 (2 DS-0 CHANNELS) FB-256 (4 DS-0 CHANNELS) FB-384 (6 DS-0 CHANNELS) FB-512 (8 DS-0 CHANNELS) FB-768 (12 DS-0 CHANNELS)				
→ a. T1 signal level				
(1) Transmit				
(a) dBdsx	93	0 dBdsx	±2 dBdsx	Same as initial
(b) Voltage	93	3 volts peak	±0.6 volts	Same as initial
(2) Receive				
(a) dBdsx	93	0 dBdsx	±2 dBdsx	Same as initial
(b) Voltage	93	3 volts peak	±0.6 volts	Same as initial
b. T1 simplex current				
(1) Minimum	93	60 mA	Same as standard	Same as initial
(2) Maximum	93	140 mA	Same as standard	Same as initial
→ c. T1 pulse mask	94	Within template	Same as standard	Same as initial
→ d. Errored seconds	93	5 or less in 1 hour	Same as standard	Same as initial
e. Percent error free seconds (%EFS)	93	<2000 miles: ≥99.9% in 24 hours	Same as standard	Same as initial
		>2000 miles: ≥99.85% in 24 hours	Same as standard	Same as initial
41. LINCS TYPES DS-1 (1.544 MB/S, CHANNELIZED FORMAT) AND DS-1B (1.544 MB/S, BULK FORMAT).				
→ a. Signal level				
(1) Transmit				
(a) dBdsx	93	0 dBdsx	±2 dBdsx	Same as initial
(b) Voltage	93	3 volts peak	±0.6 volts	Same as initial

Parameter	Reference Paragraph	Standard	Tolerance/Limit	
			Initial	Operating
(2) Receive				
(a) dBdsx	93	0 dBdsx	±2 dBdsx	Same as initial
(b) Voltage	93	3 volts peak	±0.6 volts	Same as initial
b. Simplex current				
(1) Minimum	93	60 mA	Same as standard	Same as initial
(2) Maximum	93	140 mA	Same as standard	Same as initial
→ **c. Pulse mask**	94	Within template	Same as standard	Same as initial
→ **d. Errored seconds**	93	5 or less in 1 hour	Same as standard	Same as initial
e. Percent error free seconds (%EFS)	93	<2000 miles: ≥99.9% in 24 hours	Same as standard	Same as initial
		>2000 miles: ≥99.85% in 24 hours	Same as standard	Same as initial
42.-50. RESERVED.				

CHAPTER 4. PERIODIC MAINTENANCE

51. GENERAL.

a. This chapter establishes the maintenance activities required for digital transmission lines on a periodic, recurring basis, and the schedules for their accomplishment. The chapter is divided into two sections. The first section is reserved. Section two identifies tasks that are necessary to prevent deterioration and/or ensure reliable operation.

b. The maintenance tasks presented in section two represent the maximum intervals permitted between tasks. (For guidance, refer to Order 6000.15, General Maintenance Handbook for Airway Facilities.)

Section 1. PERFORMANCE CHECKS (RESERVED)

52.-60. RESERVED.

Section 2. OTHER MAINTENANCE TASKS

Maintenance Task	*Reference Paragraph*	
	Standards and Tolerances	*Maintenance Procedures*
61. DAILY.		
Where installed, check the NMS on a regular basis for alarm icons and outstanding alarm indications. Review alarm information on the printer.	——	91
62. AS REQUIRED.		
a. On all FAA LINCS digital transmission lines, as part of initial line acceptance, verify all parameters of the particular line as identified in chapter 3.	38, 39, 40, 41	92, 93, 94
b. On all FAA LINCS digital transmission lines, to revalidate a line, perform a 15 minute stress pattern test with no errors.	——	95, 96
c. On type F, FB, DS-1 and DS-1B FAA LINCS digital transmission lines, to revalidate a line, measure pulse mask.	39c, 40c, 41c	94

Section 2. OTHER MAINTENANCE TASKS (Continued)

Maintenance Task	Reference Paragraph	
	Standards and Tolerances	*Maintenance Procedures*
d. If long-term testing is required to isolate intermittent problems, preform the percent error free seconds (%EFS) measurement for the particular line as identified in chapter 3, or perform operational shadow testing.	38d, 39e, 40e, 41e	92k, 93k, 97
63.-70. RESERVED.		

CHAPTER 5. MAINTENANCE PROCEDURES

71. GENERAL.

a. This chapter establishes the procedures for accomplishing the various essential maintenance activities required for the digital transmission lines, on either a periodic or incidental basis. The chapter is divided into two sections. The first section is reserved. The second section describes the procedures for doing the tasks listed in Chapter 4, Section 2. Refer to Order 6000.15, General Maintenance Handbook for Airway Facilities, for additional general guidance.

b. The Leased Interfacility NAS Communications System (LINCS) Orientation Handbook should be available at all locations and provides information for operation and administration of the LINCS system. The handbook contains a conceptual presentation of LINCS operation, concise procedures for optimum performance of LINCS, emergency and escalation procedures to be followed in case of a disruption of service, and interface and operation parameters to ensure that the service is operating correctly. The LINCS Orientation Handbook shall be referenced whenever system maintenance or troubleshooting is performed.

72. OBJECTIVE. The objective of this chapter is to provide specific procedures for the maintenance of digital transmission lines.

73. DISCUSSION. The following paragraphs describe common digital line measurement parameters:

a. **Bridging and Terminated Measurements.** Both bridging and terminated measurements have their place. Bridging measurements are usually made where disabling the circuit is inconvenient, where the circuit impedance is known to be a definite fixed value, or where voltage only is to be measured.

(1) Bridging. In bridging measurements, the meter is connected directly across a functioning circuit: e.g., a meter is connected across the terminals of a local loop and end-user equipment to measure power level on a bridging basis. The accuracy of this measurement depends upon how close the characteristic impedance of the loop and equipment is to the characteristic impedance of the line.

(2) Terminated. In terminated measurements a fixed resistor replaces the load normally connected to the circuit. The resistor may be internal or external to the meter. Transmission test sets usually have built-in resistors. The advantage of a terminated measurement is that the impedance of the load is known and fixed, which results in greater accuracy.

b. **Line Impedance.** When making voltage or power level measurements, attention may have to be paid to circuit impedances. Generally, however, the test equipment provides the correct impedance match to the particular line. The technician need only know if the measurement requires a terminated or bridged line.

74. TEST EQUIPMENT REQUIRED.

a. Major test equipment and adapters required for performance and installation acceptance tests on digital lines are listed in tables 5-1 and 5-2. The generic name of the of the required equipment is listed in the first column. The preferred test equipment is listed in the "Preferred Item" column. The third column lists substitute equipment that can be used if the preferred equipment is unavailable.

Table 5-1. TEST EQUIPMENT

Generic Name	Preferred Item	Substitute Item
Digital Communications Analyzer	Fireberd 6000 Options 6001, 6003 SW Version: H.1	Equivalent
Oscilloscope	Tektronix 465	Equivalent

b. A brief description of preferred test equipment and adapters follows:

(1) Fireberd 6000. The Fireberd 6000 is an instrument that analyzes the quality of digital communications. It can be used in a variety of locations, including the central office, a technical control center, end-user sites, engineering laboratories, and an earth station. The Fireberd uses digital interfaces to test T1, G.703, DDS, and synchronous/asynchronous circuits and equipment. In addition to its versatility, the Fireberd combines bit error rate testing with performance, signal, and timing analysis. Refer to appendix 1 for specific information.

(a) Features.

1 Multifunctionality. Synchronous and asynchronous testing via built-in RS-232 interface.

2 CCITT V.35, EIA RS-449, DDS, T1, ISDN, G.703, and G.704 testing via modular interfaces which can be inserted in the Fireberd 6000's rear panel.

3 Transmission of standard and non standard clock frequencies from 50 Hz to 15 MHz via a built-in synthesizer.

(b) Digital Interfaces.

1 Digital interfaces are the key to the Fireberd 6000's ability to operate in a wide range of telecommunications environments. These interfaces provide the physical connections and signal conversions that allow the instrument to connect, test, and analyze digital circuits and equipment.

2 The Fireberd's features and characteristics change based on the interface selected. Table 5-2 shows two digital interfaces available for the Fireberd 6000.

Table 5-2. FIREBERD 6000 INTERFACES

Model Number	Manual Number	Interface Label	Description
41131[1]	ML11319	DDS	DDS LOCAL LOOP Interface meets requirements for testing Digital Data Service (DDS) equipment connections to the local loop. Tests at rates from 2.4 to 56 kb/s, with secondary channel capability.
41440	ML11668	T1/FT1	T1/FT1 Data Interface meets AT&T, Bellcore, and CCITT specifications for T1 (DS-1) 1.544 mb/s and fractional T1.

[1] Fireberd interface model number 41131A is required for 64 kb/s (DDS-64) measurement capability.

b. Tektronix 465 Dual Channel Oscilloscope. The 465 is a 100 MHz dual-trace analog oscilloscope used for general test and measurement activities. The instrument has a 1 megohm, 24-picofarad input impedance. Differential measurements are made using the channel A + channel B-inverted function.

c. 4602 Intelligent Network Station. The 4602 Main Street Intelligent Network Station provides advanced network management for large and complex networks, controlling local area networks (LAN's) as well as the digital backbone wide area network (WAN). The 4602 provided under LINCS is a display-only monitor. It allows for status viewing diagnostics and statistics, and problem management of the network. Refer to appendix 2 for specific information.

75. TEST EQUIPMENT MANUALS. Manuals for the equipment listed in tables 5-1 and 5-2 are referenced in this handbook. The manuals shall be readily available as references for acceptance and maintenance of digital transmission lines.

Table 5-3. EQUIPMENT MANUALS

Equipment Name	*Model Number*	*Manual Number*
Fireberd 6000	6000	ML-10989 rev. C
DDS Local Loop Interface	41131	ML-11319 rev. A
T1/FT1 Interface	41440	ML-11732 rev. A

76.-80. RESERVED.

Section 1. PERFORMANCE CHECK PROCEDURES (RESERVED)

81.-90. RESERVED.

Section 2. OTHER MAINTENANCE TASKS

91. PROCEDURE FOR CHECKING NEWBRIDGE 4602 NMS DISPLAY-ONLY SYSTEM.

a. Object. This procedure provides the method for checking the Newbridge 4602 NMS display-only system to view the condition of the network.

b. Discussion. The NMS is a valuable tool for monitoring the health of the network. The display screen shows icons that represent both facility-level and interface-card level elements of the network. Lines that connect the icons represent the digital communication paths between facilities. A change in color of an icon or line represents a change in performance or status of that element. The printer provides a hard copy of network information for later review. When degradation of a network element has been detected, and the technician is certain that the problem is not FAA related, the Help Desk should be contacted. Refer to the LINCS Operational Handbook.

c. Test Equipment Required. Newbridge 4602 NMS display-only system.

d. Conditions. This procedure requires that the technician is familiar with the operation of the 4602 NMS display-only system and has received training on it. Instructions referring to clicking the mouse button refer to the left mouse button, unless otherwise stated.

e. Detailed Procedure - 4602 NMS Display-Only Set-Up.

(1) Verify that all components of the 4602 NMS display-only system (hereafter referred to as the NMS) are powered on. Verify also that the printer is configured for use with the NMS.

(2) If it has not already been done, log in to the system by entering the appropriate password. Upon successful log in the network map window will appear.

f. Detailed Procedure - Checking the NMS.

(1) View the NMS screen. If a red triangular sign with an exclamation mark in it is shown, click once on it. The red triangle with exclamation point is the trouble ticket icon. The trouble ticket icon indicates that a new trouble ticket in the network has been received.

(2) The screen will show the red network map element that has generated the new trouble ticket. Double click on the red network element to display the device-level view.

(3) If the red triangle with exclamation point is not shown, but there are red network elements, double click on the red network element to display the device-level view.

(4) If neither the red triangle with exclamation point or any red elements are shown in the network view, it may be necessary to refresh the display. This is accomplished by selecting any network element in the network view by clicking on it once. Next, press and hold the right mouse button down; a menu will appear. From the menu, position the mouse to select **Highlight**, and, while still holding the right mouse button, move the mouse to the right until a second menu appears. Position the mouse to select **Show Trouble Ticket** from the second menu. Release the right button.

(4) Double click on the red device-level element in the network view screen. A detail window will appear on the right side of the screen. This window shows a card-level view of the problem device.

(5) Single click on the red card-level device to select it.

(6) Press and hold the right mouse button; a menu will appear. Select **List** from the menu, and, while still holding the right mouse button, move the mouse to the right until a second menu appears. Position the mouse to select **Trouble Ticket** from the second menu. Release the right button.

(7) A trouble ticket window will appear below the device window. Click once on **Make List** from the window. Trouble tickets and their status will be listed.

(8) Double click on the trouble ticket to open it. The trouble ticket can now be viewed for status, printed, etc.

(9) Closing the trouble ticket window acknowledges the trouble ticket. Close all device-level views and return to the network view. Click on the **Map is showing objects with open trouble tickets** box in the network view. All elements in the network view will be displayed in green. Refresh the display as described in step (4), above.

(10) If an open trouble ticket is encountered, contact the MCI technician or Help Desk.

(11) Network statistics can be viewed on primary rate links (T1 rate) at any time on the NMS by performing the following:

(a) Select the primary rate link or device to be analyzed.

(b) Use the right mouse button and select **Object** then **Statistics** from the menus displayed.

(c) Specify the statistic type by clicking on the display cycle button.

(d) Select either errored seconds, severely errored seconds or failed seconds to be displayed.

(e) Click on **Show Data** to display the graph.

(f) To quit viewing statistics, click on **Done**.

92. TEST PROCEDURES FOR DDS LINES.

a. Object. This procedure provides a method of measuring signal level, simplex current, errored seconds and percent error free seconds (%EFS) of type DDS lines.

b. Discussion. Acceptance tests for type DDS lines are made using the procedures in this paragraph. Procedures for routine, periodic evaluations, in accordance with the schedules in chapter 4, are also provided. The procedures do not require service provider participation, however notification to the provider is encouraged. Observation and hard-copy printout of test results, when maintenance tests are performed by the service provider, can be used instead of FAA personnel performing actual maintenance tests.

c. Test Equipment Required. The following test equipment is identified by generic name. One each is required on each end of the line under test. Refer to tables 5-1 and 5-2 for preferred equipment listings. Refer to the appropriate user's guide and operating manual for specifics on test equipment configuration, as necessary.

(1) Digital communications analyzer.

(2) DDS local loop (DDSLL) interface.

d. Conditions. This test is performed prior to circuit turn-up. The line under test is tested from FAA demarc-to-demarc between facilities. Operational service performance tests for type DDS lines are made using the procedures in this paragraph. Procedures for routine, periodic evaluations, in accordance with the schedules in chapter 4, are provided. The procedures do not require service provider participation, however notification to the provider is encouraged. Configure and operate the test equipment at each end-facility as described below. For long-term testing (i.e., %EFS) two sets of test equipment are preferred, but one is acceptable, with the remote end loop-up.

e. Detailed Procedure - Fireberd 6000 Set-Up.

(1) If it is has not already been performed, install the appropriate DDS Local Loop Interface module into the Fireberd 6000 mainframe rear panel. This is accomplished as follows:

CAUTION: Before installing or removing the interface module, operate the Fireberd 6000 mainframe front panel POWER switch to OFF.

(2) On the rear panel, position the interface module in the data interface slot with the module faceplate facing up and out.

(3) Slide the interface module into the slot until the module front panel is flush with the mainframe rear panel.

(4) Secure the interface module to the mainframe with the module thumbscrews.

(5) Operate the Fireberd 6000 mainframe front panel POWER switch to ON.

f. Configure the Fireberd 6000 mainframe front panel controls to generate the BER test pattern in the internal self loop mode. This step verifies the integrity of the test set itself, and is accomplished as follows:

(1) Press the SELF LOOP key to illuminate its LED indicator.

(2) Press the DATA key until the 2047 test pattern is selected.

(3) Press the GEN CLK key and verify that only the GEN CLK INTF signal timing source can be selected.

(4) Press the MENU key until the INTF SETUP menu is selected.

(5) Press the **DDSLL** softkey to select the DDS Local Loop Interface module. The INTERFACE

display should indicate **DDSLL.**

(6) Press the **RATE** softkey to select the RATE menu.

(7) Select the 56 kb/s primary data rate. This is accomplished as follows:

(a) Press the MORE key once.

(b) Press the **56.0K** softkey. The **PRI RATE** display should indicate **56.0K.**

(8) Return to the main DDSLL menu by pressing the "▲" key once on the entry keypad.

(9) Press the **CHAN** softkey to select the CHAN menu.

(10) Press the **ON** softkey to enable the secondary channel.

(11) Press the **PRI** softkey to select the primary channel as the analysis channel.

(12) Press the **2047** softkey. The **SEC PATTERN** display should indicate **2047.**

(13) Return to the main DDSLL menu by pressing the "▲" key three times on the entry keypad.

(14) Press the **TXLVL** softkey to select the TXLVL menu.

(15) Press the **0 dB** softkey to select the 0 dB transmit level. The **TX LEVEL** display should indicate **0dB.**

(16) Return to the main DDSLL menu by pressing the "▲" key once on the entry keypad.

(17) Press the MORE key display the remaining DDSLL menus.

(18) Press the **TXCLK** softkey to select the TXCLK menu.

(19) Press the **RECOV** softkey to select the incoming data as the transmit timing clock source. The **TX CLOCK** display should indicate **RECOV.**

(20) Return to the main DDSLL menu by pressing the "▲" key once on the entry keypad.

(21) Disable the automatic error insertion capability. This is accomplished as follows:

(a) Press the **ERRINS** softkey to select the ERRINS menu.

(b) Press the **OFF** softkey.

(22) Return to the main INTF SETUP menu by pressing the "▲" key twice on the entry keypad.

(23) Press the ANALYSIS RESULTS CATEGORY keys to select ERROR on both displays.

(24) Press the left ANALYSIS RESULTS RESULT key until **BIT ERRS** is displayed.

(25) Press the right ANALYSIS RESULTS RESULT key until **AVG BER** is displayed.

(26) Press the ANALYSIS MODE key until CONTINUOUS is displayed.

(27) Verify the condition of the following interface status LED indicators and keys.

(a) RECEIVER MK: ON (illuminated)

(b) RECEIVER SP: ON

(c) RECEIVER SYNC: ON

(d) SYNC LOST: OFF

(e) FRM SYNCH: ON

(f) CODE: OFF

(g) ALM1: OFF

(h) ALM2: ON

g. Verify the Fireberd 6000 communications analyzer self loop operation. This is accomplished as follows:

(1) Press the RESTART key to clear the test set.

(2) Press the ERROR INSERT key. Observe that the **BIT ERRS** display count increases.

(3) Press the RESTART key to clear the test set.

(4) Press the SELF LOOP key to extinguish its LED indicator.

h. Detailed Procedure - Measuring Signal Level, Simplex Current, and Errored Seconds of Type DDS Lines.

(1) Perform the Fireberd 6000 initial set-up as described in steps e, f, and g above.

(2) Connect the interface cable RJ-45 modular phone plug into the DDS local loop interface module modular phone jack.

(3) Connect the interface cable RX bantam plug to the DDS digital jackfield LINE OUT jack. Connect the interface cable TX bantam plug to the DDS digital jackfield LINE IN jack.

(4) Press the MENU key until the INTF SETUP category is selected.

(5) Press the **DDSLL** softkey. Use the **RATE** softkey and MORE key to select the appropriate data rate of the channel under test.

(6) Press the MENU key until the AUXILIARY category is selected. Press the **LIST** softkey.

(7) Use the **FWD/RVRS** softkeys to display auxiliary function **41 USER PATTERN**.

(8) Press the **SELECT** softkey. Use the MORE key and softkeys to select the **DDS-6** user pattern.

(9) Press the ANALYSIS RESULTS left CATEGORY key to select SIGNAL.

(10) Press the left ANALYSIS RESULTS RESULT key until **R LVL Db** is displayed.

(11) Verify that the receive level is within the operating tolerance specified in chapter 3.

(12) Press the left ANALYSIS RESULTS RESULT key until **SMPX CUR** is displayed.

(13) Verify that the simplex current is within the operating tolerance specified in chapter 3.

(14) Press the ANALYSIS RESULTS left CATEGORY key to select TIME.

(15) Press the left ANALYSIS RESULTS RESULT key until **ELAP SEC** is displayed.

(16) Press the ANALYSIS RESULTS right CATEGORY key to select PERFORMANCE.

(17) Press the right ANALYSIS RESULTS RESULT key until **AVL SEC** is displayed.

(18) Press the RESTART key to clear the test set.

(19) Monitor the channel for 1 hour (3600 seconds). At the end of the hour, verify that the **AVL SEC** value equals the **ELAP SEC** value. If **AVL SEC** is less than **ELAP SEC**, the line has failed the test.

(20) Press the right ANALYSIS RESULTS RESULT key until **GERR SEC** (errored seconds) is displayed.

(21) Verify that **GERR SEC** is within the operating tolerance specified in chapter 3.

i. If any requirement cannot be met, notify the service provider immediately.

j. Return all equipment and lines to normal operating status.

k. Detailed Procedure - Measuring Percent Error Free Seconds (%EFS) of Type DDS lines.

(1) Perform the Fireberd 6000 initial set-up as described in steps e, f, and g above.

(2) Connect the interface cable RJ-45 modular phone plug into the DDS local loop interface module modular phone jack.

(3) Connect the interface cable RX bantam plug to the DDS digital jackfield LINE OUT jack. Connect the interface cable TX bantam plug to the DDS digital jackfield LINE IN jack.

(4) Press the MENU key until the INTF SETUP category is selected.

(5) Press the **DDSLL** softkey. Use the **RATE** softkey to select the appropriate data rate of the channel under test.

(6) Press the MENU key until the AUXILIARY category is selected.

(7) Press the **LIST** softkey. Use the **FWD/-RVRS** softkeys to display auxiliary function **41 USER PATTERN.**

(8) Use the MORE key and softkeys to select the **DDS-6** stress pattern.

(9) Press the ANALYSIS RESULTS left CATEGORY key to select PERFORMANCE.

(10) Press the left ANALYSIS RESULTS RESULT key until **G %EFS** is displayed.

(11) Press the RESTART key to clear the test set.

(12) Monitor the channel for 24 hours. Verify that the percent error free seconds (%EFS) is within the operating tolerance specified in chapter 3.

l. If the requirement cannot be met, notify the service provider immediately.

m. Return all equipment and lines to normal operating status.

93. TEST PROCEDURES FOR TYPE F, FB, DS-1 AND DS-1B LINES.

a. Object. This procedure provides a method of measuring signal level, simplex current, errored seconds and percent error free seconds (%EFS) of type F, FB, DS-1 and DS-1B lines.

b. Discussion. Acceptance tests for type F, FB, DS-1 and DS-1B lines are made using the procedures in this paragraph. Procedures for routine, periodic evaluations, in accordance with the schedules in chapter 4, are also provided. The procedures do not require service provider participation, however notification to the provider is encouraged. Observation and hard-copy printout of test results, when maintenance tests are performed by the service provider, can be used instead of FAA personnel performing actual maintenance tests.

c. Test Equipment Required. The following test equipment is identified by generic name. One each is required on each end of the line under test. Refer to tables 5-1 and 5-2 for preferred equipment listings. Refer to the appropriate user's guide and operating manual for specifics on test equipment configuration, as necessary.

(1) Digital communications analyzer.

(2) T1/FT1 data interface.

d. Conditions. This test is performed prior to circuit turn-up. The line under test is tested from FAA demarc-to-demarc between facilities. Operational service performance tests for types F, FB, DS-1, and DS-1B lines are made using the procedures in this paragraph. Procedures for routine, periodic evaluations, in accordance with the schedules in chapter 4, are provided. The procedures do not require service provider participation, however notification to the provider is encouraged. Configure and operate the test equipment at each end-facility as described below.

For long-term testing (i.e., %EFS) two sets of test equipment are preferred, but one is acceptable, with the remote end looped-up.

e. Detailed Procedure - Fireberd 6000 Set-Up.

(1) If it has not already been performed, install the T1/FT1 Data Interface module into the Fireberd 6000 mainframe rear panel. This may be accomplished as follows.

CAUTION: Before installing or removing the interface module, operate the Fireberd 6000 mainframe front panel POWER switch to OFF.

(2) On the rear panel, position the interface module in the data interface slot with the module faceplate facing up and out.

(3) Slide the interface module into the slot until the module front panel is flush with the mainframe rear panel.

(4) Secure the interface module to the mainframe with the module thumbscrews.

(5) Operate the Fireberd 6000 mainframe front panel POWER switch to ON.

f. Configure the Fireberd 6000 mainframe front panel controls to generate the BER test pattern in the internal self loop mode. This step verifies the integrity of the test set itself. This is accomplished as follows:

(1) Press the SELF LOOP key to illuminate its LED indicator.

(2) Press the DATA key until the QRSS test pattern is selected.

(3) Press the GEN CLK key until the SYNTH signal timing source is selected.

(4) Press the MENU key until the SYNTH FREQ menu is selected.

(5) Select the 1544 kHz synthesizer frequency. This is accomplished as follows:

(a) Press the MORE key twice.

(b) Press the **1544 kHz** softkey. The **SYNTH FREQ** display should indicate **1544kHz.**

(6) Press the MENU key to select the INTF SETUP menu.

(7) Press the **T1/FT1** softkey to select the T1/FT1 Data Interface module. The **INTERFACE** display should indicate **T1/FT1.**

(8) Press the **MODE** softkey to select the MODE menu.

(9) Press the **FULLT1** softkey. The **MODE** display should indicate **FULLT1.**

(10) Return to the main T1/FT1 menu by pressing the "▲" key once on the entry keypad.

(11) Press the **CONFIG** softkey to select the CONFIG menu.

(12) Press the **FRAME** softkey until **ESF** appears in the **CONFIG** display.

(13) Press the **CODE** softkey until **B8ZS** appears in the **CONFIG** display

(14) Press the **INPUT** softkey until **TERM** appears in the **CONFIG** display.

(15) Return to the main T1/FT1 menu by pressing the "▲" key once on the entry keypad.

(16) Disable the automatic error insertion capability. This is accomplished as follows:

(a) Press the **ERRINS** softkey to select the ERRINS menu.

(b) Press the **OFF** softkey.

(17) Return to the main T1/FT1 menu by pressing the "▲" key once on the entry keypad.

(18) Press the ANALYSIS RESULTS

CATEGORY keys to select ERROR on both displays.

(19) Press the left ANALYSIS RESULTS RESULT key until **BIT ERRS** is displayed.

(20) Press the right ANALYSIS RESULTS RESULT key until **AVG BER** is displayed.

(21) Press the ANALYSIS MODE key until CONTINUOUS is displayed.

(22) Verify the condition of the following interface status LED indicators and keys.

(a) RECEIVER MK: ON (illuminated)

(b) RECEIVER SP: ON

(c) RECEIVER SYNC: ON

(d) SYNC LOST: OFF

(e) FRM SYNC: ON

(f) CODE: ON

(g) ALM1: OFF

(h) ALM2: OFF

(i) LOOP UP: OFF

(j) LOOP DOWN: OFF

g. Verify the Fireberd 6000 communications analyzer self loop operation. This is accomplished as follows:

(1) Press the RESTART key to clear the test set.

(2) Press the ERROR INSERT key.

REQUIREMENT: The **BIT ERRS** display count increases.

(3) Press the RESTART key to clear the test set.

(4) Press the SELF LOOP key to extinguish its LED indicator.

h. Detailed Procedure - Measuring Signal Level, Simplex Current, and Errored Seconds of Type F, FB, DS-1 and DS-1B lines.

(1) Perform the Fireberd 6000 initial set-up as described in steps e, f, and g above.

(2) Connect the interface cable RX bantam plug into the T1/FT1 interface adaptor module INPUT RX jack. Connect the interface cable TX bantam plug into the T1/FT1 interface adaptor module OUTPUT TX jack.

(3) Connect the RX bantam plug on the other end of the interface cable into the DSX cross connect jackfield LINE OUT jack. Connect the TX bantam plug in the other end of the interface cable into the DSX cross connect jackfield LINE IN jack.

(4) Press the MENU key until SYNTH FREQ menu is selected.

(5) Use the softkeys and MORE key to select the appropriate data rate of the channel under test.

(6) Press the MENU key to select the INTF SETUP menu.

(7) Press the **T1/FT1** softkey to select the T1/FT1 Data Interface module. The **INTERFACE** display should indicate **T1/FT1**.

(8) Press the **MODE** softkey to select the MODE menu.

(9) Press the appropriate softkey(s) to select the desired operating mode and channels, as required.

(10) Return to the main menu by pressing the "▲" key on the entry keypad twice.

(11) Press the MENU key until the AUXILIARY category is selected.

(12) Press the LIST softkey. Use the **FWD/-**

RVRS softkeys to display auxiliary function **41 USER PATTERN**.

(13) Press the **SELECT** softkey. Use the MORE key and softkeys to select the **T1-4** (120 octet) user pattern.

(14) Press the ANALYSIS RESULTS left CATEGORY key to select SIGNAL.

(15) Press the left ANALYSIS RESULTS RESULT key until **+LVL V** (peak positive voltage) is displayed.

(16) Verify that the level is within the operating tolerance specified in chapter 3.

(17) Press the left ANALYSIS RESULTS RESULT key until **+LVL dB** is displayed.

(18) Verify that the level is within the operating tolerance specified in chapter 3.

(19) Press the left ANALYSIS RESULTS RESULT key until **-LVL V** (peak negative voltage) is displayed.

(20) Verify that the level is within the operating tolerance specified in chapter 3.

(21) Press the left ANALYSIS RESULTS RESULT key until **-LVL dB** is displayed.

(22) Verify that the level is within the operating tolerance specified in chapter 3.

(23) Press the left ANALYSIS RESULTS RESULT key until **SMPX CUR** is displayed.

(24) Verify that the simplex current is within the operating tolerance specified in chapter 3.

(25) Press the ANALYSIS RESULTS left CATEGORY key to select TIME.

(26) Press the left ANALYSIS RESULTS RESULT key until **ELAP SEC** is displayed.

(27) Press the ANALYSIS RESULTS right CATEGORY key to select PERFORMANCE.

(28) Press the right ANALYSIS RESULTS RESULT key until **AVL SEC** is displayed.

(29) Press the RESTART key to clear the test set.

(30) Monitor the channel for 1 hour (3600 seconds). At the end of the hour, verify that the **AVL SEC** value equals the **ELAP SEC** value. If **AVL SEC** is less than **ELAP SEC, the line has failed the test.**

(31) Press the right ANALYSIS RESULTS RESULT key until **GERR SEC** (errored seconds) is displayed.

(32) Verify that **GERR SEC** is within the operating tolerance specified in chapter 3.

i. If any requirement cannot be met, notify the service provider immediately.

j. Return all equipment and lines to normal operating status.

k. Detailed Procedure - Measuring Percent Error Free Seconds (%EFS) of Type F, FB, DS-1 and DS-1B lines.

(1) Perform the Fireberd 6000 initial set-up as described in steps e, f, and g above.

(2) Connect the interface cable RX bantam plug into the T1/FT1 interface adaptor module INPUT RX jack. Connect the interface cable TX bantam plug into the T1/FT1 interface adaptor module OUTPUT TX jack.

(3) Connect the RX bantam plug on the other end of the interface cable into the DSX cross connect jackfield LINE OUT jack. Connect the TX bantam plug in the other end of the interface cable into the DSX cross connect jackfield LINE IN jack.

(4) Press the MENU key until the SYNTH

FREQ menu is selected.

(5) Use the softkeys and MORE key to select the appropriate data rate of the channel under test.

(6) Press the MENU key to select the INTF SETUP menu.

(7) Press the **T1/FT1** softkey to select the T1/FT1 Data Interface module. The **INTERFACE** display should indicate **T1/FT1**.

(8) Press the **MODE** softkey to select the MODE menu.

(9) Press the appropriate softkey(s) to select the desired operating mode and channels, as required.

(10) Return to the main menu by pressing the "▲" key on the entry keypad twice.

(11) Press the MENU key until the AUXILIARY category is selected.

(12) Press the **LIST** softkey. Use the **FWD/-RVRS** softkeys to display auxiliary function **41 USER PATTERN**.

(13) Use the MORE key and softkeys to select the **T1-4** (120 octet) user pattern.

(14) Press the ANALYSIS RESULTS left CATEGORY key to select PERFORMANCE.

(15) Press the left ANALYSIS RESULTS RESULT key until **G %EFS** is displayed.

(16) Press the RESTART key to clear the test set.

* (17) Monitor the channel for 4 hours. Verify that the percent error free seconds (%EFS) meets the standard specified in chapter 3. The %EFS measured over a 4-hour period is assumed to be valid for verifying the chapter 3 standard, which is specified over a 24 hour period. *

l. If the requirement cannot be met, notify the service provider immediately.

m. Return all equipment and lines to normal operating status.

94. TEST PROCEDURES FOR PULSE MASK MEASUREMENT.

a. Object. This procedure provides a method performing a T1 pulse mask measurement for types F, FB, DS-1 and DS-1B digital transmission lines.

b. Discussion. This procedure is used for initial acceptance, and revalidation after an outage, of type F, FB, DS-1 and DS-1B lines. Construction of a simple circuit is required to match the impedance of the T1 line to the oscilloscope. The technician should construct the circuit before performing the procedures. The procedures do not require service provider participation; however, notification to the provider is encouraged. Observation and hard-copy printout of test results, when maintenance tests are performed by the service provider, can be used instead of FAA personnel performing actual maintenance tests. The procedures must be performed at each end-facility for the line under test; and, therefore, coordination between the two end-facilities is required.

c. Test Equipment Required. The following test equipment is identified by generic name. One each is required on each end of the line under test. Refer to tables 5-1 and 5-2 for preferred equipment listings. Refer to the appropriate user's guide and operating manual for specifics on test equipment configuration, as necessary.

(1) Digital communications analyzer.

(2) T1/FT1 interface.

(3) Oscilloscope.

d. Conditions. This is an intrusive test, and requires coordination with air traffic (AT) before testing. The line under test is tested from FAA demarc-to-demarc between facilities. Ensure that the line is available and that all services on the line have been rerouted. Operational service performance tests for type F, FB, DS-1 and DS-1B lines are made using the procedures in this paragraph. Procedures for schedules in chapter 4, are provided. The procedures do not require service provider participation, however notification to the provider is encouraged. Configure and operate the test equipment at each end-facility as described below.

e. Detailed Procedure - Fireberd 6000 Set-Up.

(1) If it has not already been performed, install the T1/FT1 Data Interface module into the Fireberd 6000 mainframe rear panel. This is accomplished as follows:

CAUTION: Before installing or removing the interface module, operate the Fireberd 6000 mainframe front panel POWER switch to OFF.

(2) On the rear panel, position the interface module in the data interface slot with the module faceplate facing up and out.

(3) Slide the interface module into the slot until the module front panel is flush with the mainframe rear panel.

(4) Secure the interface module to the mainframe with the module thumbscrews.

(5) Operate the Fireberd 6000 mainframe front panel POWER switch to ON.

f. Configure the Fireberd 6000 mainframe front panel controls to generate the BER test pattern in the internal self loop mode. This step verifies the integrity of the test set itself. This is accomplished as follows:

(1) Press the SELF LOOP key to illuminate its LED indicator.

(2) Press the DATA key until USER is selected.

(3) Press the MENU key until the AUXILIARY category is selected.

(4) Press the **LIST** softkey. Use the **FWD/RVRS** softkeys to display the auxiliary function **41 USER PATTERN.**

(5) Use the MORE key and softkeys to select the **1:7** pattern.

(6) Press the GEN CLK key until the SYNTH signal timing source is selected.

(7) Press the MENU key until the SYNTH FREQ menu is selected.

(8) Select the 1544 kHz synthesizer frequency. This is accomplished as follows:

(a) Press the MORE key twice.

(b) Press the **1544** softkey. The **SYNTH FREQ** display should indicate **1544kHz.**

(9) Press the MENU key to select the INTF SETUP menu.

(10) Press the **T1/FT1** softkey to select the T1/FT1 Data Interface module. The **INTERFACE display** should indicate **T1/FT1.**

(11) Press the **MODE** softkey to select the MODE menu.

(12) Press the **FULLT1** softkey. The **MODE** display should indicate **FULLT1.**

(13) Return to the main T1/FT1 menu by pressing the "▲" key once on the entry keypad.

(14) Press the **CONFIG** softkey to select the CONFIG menu.

(15) Press the **FRAME** softkey until **ESF** appears in the **CONFIG** display.

(16) Press the **CODE** softkey until **B8ZS** appears in the **CONFIG** display.

(17) Press the **INPUT** softkey until **TERM** appears in the **CONFIG** display.

(18) Return to the main T1/FT1 menu by

pressing the "▲" key once on the entry keypad.

(19) Disable the automatic error insertion capability. This is accomplished as follows:

(a) Press the **ERRINS** softkey to select the ERRINS menu.

(b) Press the **OFF** softkey.

(20) Return to the main T1/FT1 menu by pressing the "▲" key once on the entry keypad.

(21) Press the ANALYSIS RESULTS CATEGORY keys to select ERROR on both displays.

(22) Press the left ANALYSIS RESULTS RESULT key until **BIT ERRS** is displayed.

(23) Press the right ANALYSIS RESULTS RESULT key until **AVG BER** is displayed.

(24) Press the ANALYSIS MODE key until CONTINUOUS is displayed.

(25) Verify the condition of the following interface status LED indicators and keys.

(a) RECEIVER MK: ON (illuminated)

(b) RECEIVER SP: ON

(c) RECEIVER SYNC: ON

(d) SYNC LOST: OFF

(e) FRM SYNC: ON

(f) CODE: ON

(g) ALM1: OFF

(h) ALM2: OFF

(i) LOOP UP: OFF

(j) LOOP DOWN: OFF

g. Verify the Fireberd 6000 communications analyzer self loop operation. This is accomplished as follows:

(1) Press the RESTART key to clear the test set.

(2) Press the ERROR INSERT key.

REQUIREMENT: The BIT ERRS display count increases.

(3) Press the RESTART key to clear the test set.

(4) Press the SELF LOOP key to extinguish its LED indicator.

h. Connect the transmit side of the Fireberd 6000 to the DSX cross connect jackfield. This is accomplished as follows:

(1) Connect the interface cable TX bantam plug into the T1/FT1 interface adaptor module OUTPUT TX jack.

(2) Connect the free bantam plug of the interface cable to the DSX cross connect jackfield LINE IN jack.

(3) Press the MENU key until the INTF SETUP menu is selected.

(4) Use the **RATE** softkey to select the appropriate data rate of the channel under test.

(5) Return to the main menu by pressing the "▲" key on the entry keypad.

(6) Press the **T1/FT1** softkey to select the T1/FT1 Data Interface module. The **INTERFACE** display should indicate **T1/FT1**.

(7) Press the **MODE** softkey to select the MODE menu.

(8) Press the appropriate softkey(s) to select the desired operating mode.

i. Verify that the other end-facility is configured correctly. This is accomplished as follows:

(1) Temporarily connect the interface cable RX bantam plug into the T1/FT1 interface adaptor module INPUT RX jack.

(2) Verify that the SYNC lamp illuminates and that errors can be sent and received.

(3) Disconnect the RX bantam plug from the T1/FT1 interface module adaptor INPUT RX jack.

j. Detailed Procedure - Tektronix 465 Set-Up.

(1) Power on the oscilloscope by pulling the POWER switch.

(2) Check the accuracy of the scope probes used for the channel 1 and 2 measurement. Connect each scope probe to the CAL bar on the front of the scope. View the display and adjust the scope probe for a square waveform.

(3) Configure the scope as follows:

(a) CH 1: AC, 1V/DIV

(b) CH 2: AC, 1V/DIV, INVERT (button in)

(c) VERT: ADD

(d) TIME/DIV: 0.1 uS/DIV

(e) SOURCE: NORM

(f) TRIG MODE: AUTO

(g) COUPLING: AC

(h) HORIZ DISPLAY: A LOCK KNOBS

k. Detailed Procedure - Pulse Mask Measurement.

(1) Connect both scope probes to the CAL bar and verify that a horizontal trace is present.

(2) Position the template supplied in chapter 7 on the oscilloscope screen so that the dotted lines on the template are aligned with the lines on the oscilloscope. For reference, a pulse mask template is shown in figure 5-1.

(3) Connect the oscilloscope to the circuit shown in figure 5-2 for the line under test.

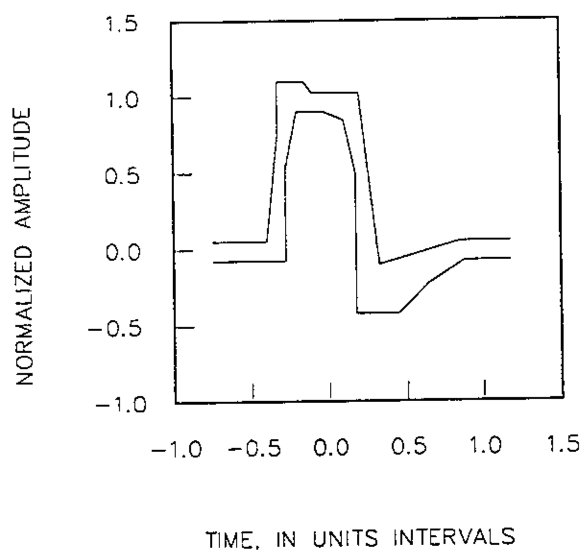


Figure 5-1. Pulse Mask

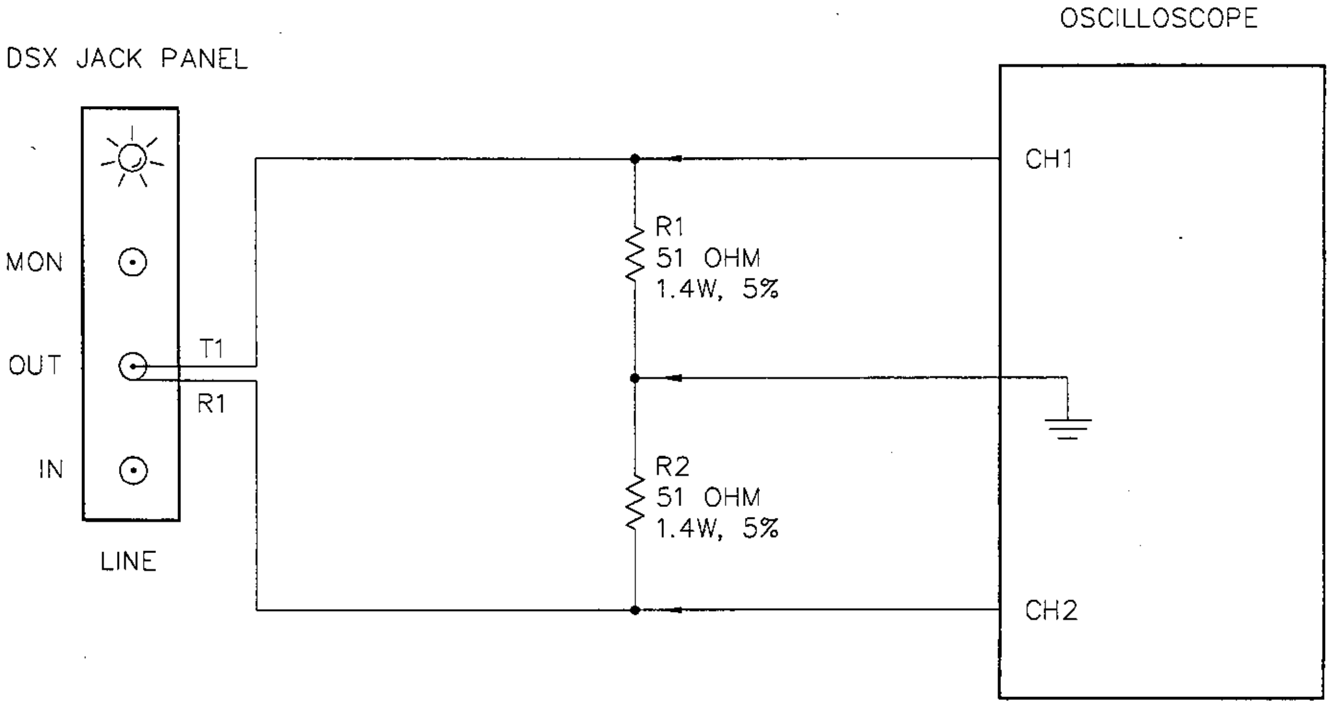


Figure 5-2. Pulse Mask Test Circuit

(4) Adjust the A TRIGGER knob to obtain an oscilloscope waveform with orientation that is compatible with template orientation.

(5) Adjust the horizontal FINE POSITION and CH 1 vertical POSITION controls for the best fit of the waveform in the template.

l. If the waveform is significantly outside of the template borders, notify the service provider immediately.

m. Return all equipment and lines to normal operating status.

95. STRESS PATTERN TEST PROCEDURES FOR DDS LINES.

a. Object. This procedure provides a method of revalidating service of type DDS lines.

b. Discussion. Revalidation tests for type DDS lines are made using the procedures in this paragraph. Procedures for routine, periodic evaluations, in accordance with the schedules in chapter 4, are also provided. The procedures do not require service provider participation, however notification to the provider is encouraged. Observation and hard-copy printout of test results, when maintenance tests are performed by the service provider, can be used instead of FAA personnel performing actual maintenance tests.

c. Test Equipment Required. The following test equipment is identified by generic name. One each, on each end of the line under test is the preferred configuration for this test, however, the test may be run from one end, with the other end looped-up. Refer to tables 5-1 and 5-2 for preferred equipment listings. Refer to the appropriate user's guide and operating manual for specifics on test equipment configuration, as necessary.

(1) Digital communications analyzer.

(2) DDS local loop (DSLL) interface.

d. **Conditions.** This test is performed after service has been restored and prior to circuit turn-up. The line under test is tested from FAA demarc-to-demarc between facilities. Operational service performance tests for type DDS lines are made using the procedures in this paragraph. The procedures do not require service provider participation, however notification to the provider is encouraged. Configure and operate the test equipment as described below. In this test, two sets of test equipment are preferred, but one is acceptable, with the other end looped-up.

e. **Detailed Procedure - Fireberd 6000 Set-Up.**

(1) If it is has not already been performed, install the appropriate DDS Local Loop Interface module into the Fireberd 6000 mainframe rear panel. This is accomplished as follows:

CAUTION: Before installing or removing the interface module, operate the Fireberd 6000 mainframe front panel POWER switch to OFF.

(2) On the rear panel, position the interface module in the data interface slot with the module faceplate facing up and out.

(3) Slide the interface module into the slot until the module front panel is flush with the mainframe rear panel.

(4) Secure the interface module to the mainframe with the module thumbscrews.

(5) Operate the Fireberd 6000 mainframe front panel POWER switch to ON.

f. Configure the Fireberd 6000 mainframe front panel controls to generate the BER test pattern in the internal self loop mode. This step verifies the integrity of the test set itself, and is accomplished as follows:

(1) Press the SELF LOOP key to illuminate its LED indicator.

(2) Press the DATA key until the 2047 test pattern is selected.

(3) Press the GEN CLK key and verify that only the GEN CLK INTF signal timing source can be selected.

(4) Press the MENU key until the INTF SETUP menu is selected.

(5) Press the **DDSLL** softkey to select the DDS Local Loop Interface module. The **INTERFACE** display should indicate **DDSLL**.

(6) Press the **RATE** softkey to select the RATE menu.

(7) Select the 56 kb/s primary data rate. This is accomplished as follows:

(a) Press the MORE key once.

(b) Press the **56.0K** softkey. The **PRI RATE** display should indicate **56.0K.**

(8) Return to the main **DDSLL** menu by pressing the "▲" key once on the entry keypad.

(9) Press the **CHAN** softkey to select the CHAN menu.

(10) Press the **ON** softkey to enable the secondary channel.

(11) Press the **PRI** softkey to select the primary channel as the analysis channel.

(12) Press the **2047** softkey. The **SEC PATTERN** display should indicate **2047.**

(13) Return to the main **DDSLL** menu by pressing the "▲" key three times on the entry keypad.

(14) Press the **TXLVL** softkey to select the TXLVL menu.

(15) Press the **0dB** softkey to select the 0 dB transmit level. The **TX LEVEL** display should indicate **0dB.**

(16) Return to the main **DDSLL** menu by pressing the "▲" key once on the entry keypad.

(17) Press the MORE key display the remaining DDSLL menus.

(18) Press the **TXCLK** softkey to select the TXCLK menu.

(19) Press the **RECOV** softkey to select the incoming data as the transmit timing clock source. The **TX CLOCK** display should indicate **RECOV.**

(20) Return to the main DDSLL menu by pressing the "▲" key once on the entry keypad.

(21) Disable the automatic error insertion capability. This is accomplished as follows:

(a) Press the **ERRINS** softkey to select the ERRINS menu.

(b) Press the **OFF** softkey.

(22) Return to the main INTF SETUP menu by pressing the "▲" key twice on the entry keypad.

(23) Press the ANALYSIS RESULTS CATEGORY keys to select ERROR on both displays.

(24) Press the left ANALYSIS RESULTS RESULT key until **BIT ERRS** is displayed.

(25) Press the right ANALYSIS RESULTS RESULT key until **AVG BER** is displayed.

(26) Press the ANALYSIS MODE key until CONTINUOUS is displayed.

(27) Verify the condition of the following interface status LED indicators and keys.

(a) RECEIVER MK: ON (illuminated)

(b) RECEIVER SP: ON

(c) RECEIVER SYNC: ON

(d) SYNC LOST: OFF

(e) FRM SYNCH: ON

(f) CODE: OFF

(g) ALM1: OFF

(h) ALM2: ON

g. Verify the Fireberd 6000 communications analyzer self loop operation. This is accomplished as follows:

(1) Press the RESTART key to clear the test set.

(2) Press the ERROR INSERT key. Observe that the BIT ERRS display count increases.

(3) Press the RESTART key to clear the test set.

(4) Press the SELF LOOP key to extinguish its LED indicator.

h. Detailed Procedure - Stress Pattern Testing of Type DDS Lines.

(1) Perform the Fireberd 6000 initial set-up as described in steps e, f, and g above.

(2) Connect the interface cable RJ-45 modular phone plug into the DDS local loop interface module modular phone jack.

(3) Connect the interface cable RX bantam plug to the DDS digital jackfield LINE OUT jack. Connect the interface cable TX bantam plug to the DDS digital jackfield LINE IN jack.

(4) Press the MENU key until the INTF SETUP category is selected.

(5) Press the **DDSLL** softkey. Use the **RATE** softkey and MORE key to select the appropriate data rate of the channel under test.

(6) Press the MENU key until the AUXILIARY category is selected.

(7) Use the **FWD/RVRS** softkeys to display auxiliary function **41 USER PATTERN**.

(8) Press the **SELECT** softkey. Use the MORE key and softkeys to select the **DDS-6** user pattern.

(9) Press the ANALYSIS RESULTS left CATEGORY key to select TIME.

(10) Press the left ANALYSIS RESULTS RESULT key until **ELAP SEC** is displayed.

(11) Press the ANALYSIS RESULTS right CATEGORY key to select PERFORMANCE.

(12) Press the right ANALYSIS RESULTS RESULT key until **AVL SEC** is displayed.

(13) Press the RESTART key to clear the test set.

(14) Monitor the channel for 15 minutes (900 seconds). At the end of the 15 minutes, verify that the **AVL SEC** value equals the **ELAP SEC** value. If **AVL SEC** is less than **ELAP SEC**, the line has failed the test.

(15) Press the ANALYSIS RESULTS right CATEGORY key to select ERROR.

(16) Press the right ANALYSIS RESULTS RESULT key until **BIT ERRS** (bit errors) is displayed.

(17) Verify that no **BIT ERRS** have been recorded in the 15-minute period.

i. If any requirement cannot be met, perform the test a second time. If the test fails a second time,
* notify the service provider immediately and begin a 4-hour %EFS test on the line, as described in paragraph 92k. *

j. Return all equipment and lines to normal operating status.

96. STRESS PATTERN TEST PROCEDURES FOR TYPE F, FB, DS-1 AND DS-1B LINES.

a. **Object.** This procedure provides a method of revalidating service of type F, FB, DS-1 and DS-1 lines.

b. **Discussion.** Revalidation tests for type F, FB, DS-1 and DS-1B lines are made using the procedures in this paragraph. Procedures for routine, periodic evaluations, in accordance with the schedules in chapter 4, are also provided. The procedures do not require service provider participation, however notification to the provider is encouraged. Observation and hard-copy printout of test results, when maintenance tests are performed by the service provider, can be used instead of FAA personnel performing actual maintenance tests.

c. **Test Equipment Required.** The following test equipment is identified by generic name. One each, on each end of the line under test is the preferred configuration for this test, however, the test may be run from one end, with the other end looped-up. Refer to tables 5-1 and 5-2 for preferred equipment listings. Refer to the appropriate user's guide and operating manual for specifics on test equipment configuration, as necessary.

(1) Digital communications analyzer.

(2) T1/FT1 data interface.

d. **Conditions.** This test is performed after service has been restored and prior to circuit turn-up. The line under test is tested from FAA demarc-to-demarc between facilities. Operational service performance tests for types F, FB, DS-1, and DS-1B lines are made using the procedures in this paragraph. The procedures do not require service provider participation, however notification to the provider is encour aged. Configure and operate the test equipment as described below. In this test, two sets of test equipment are preferred, but one is acceptable, with the other end looped-up.

e. Detailed Procedure - Fireberd 6000 Set-Up.

(1) If it has not already been performed, install the T1/FT1 Data Interface module into the Fireberd 6000 mainframe rear panel. This may be accomplished as follows.

CAUTION: Before installing or removing the interface module, operate the Fireberd 6000 mainframe front panel POWER switch to OFF.

(2) On the rear panel, position the interface module in the data interface slot with the module faceplate facing up and out.

(3) Slide the interface module into the slot until the module front panel is flush with the mainframe rear panel.

(4) Secure the interface module to the mainframe with the module thumbscrews.

(5) Operate the Fireberd 6000 mainframe front panel POWER switch to ON.

f. Configure the Fireberd 6000 mainframe front panel controls to generate the BER test pattern in the internal self loop mode. This step verifies the integrity of the test set itself. This is accomplished as follows:

(1) Press the SELF LOOP key to illuminate its LED indicator.

(2) Press the DATA key until the QRSS test pattern is selected.

(3) Press the GEN CLK key until the SYNTH signal timing source is selected.

(4) Press the MENU key until the SYNTH FREQ menu is selected.

(5) Select the 1544 kHz synthesizer frequency. This is accomplished as follows:

(a) Press the MORE key twice.

(b) Press the **1544** softkey. The **SYNTH FREQ** display should indicate **1544kHz.**

(6) Press the MENU key to select the INTF SETUP menu.

(7) Press the **T1/FT1** softkey to select the T1/FT1 Data Interface module. The **INTERFACE** display should indicate **T1/FT1.**

(8) Press the **MODE** softkey to select the MODE menu.

(9) Press the **FULLT1** softkey. The MODE display should indicate **FULLT1.**

(10) Return to the main T1/FT1 menu by pressing the "▲" key once on the entry keypad.

(11) Press the **CONFIG** softkey to select the CONFIG menu.

(12) Press the **FRAME** softkey until **ESF** appears in the **CONFIG** display.

(13) Press the **CODE** softkey until **B8ZS** appears in the **CONFIG** display

(14) Press the **INPUT** softkey until **TERM** appears in the **CONFIG** display.

(15) Return to the main T1/FT1 menu by pressing the "▲" key once on the entry keypad.

(16) Disable the automatic error insertion capability. This is accomplished as follows:

(a) Press the **ERRINS** softkey to select the ERRINS menu.

(b) Press the **OFF** softkey.

(17) Return to the main T1/FT1 menu by pressing the "▲" key once on the entry keypad.

(18) Press the ANALYSIS RESULTS CATEGORY keys to select ERROR on both displays.

(19) Press the left ANALYSIS RESULTS RESULT key until **BIT ERRS** is displayed.

(20) Press the right ANALYSIS RESULTS RESULT key until **AVG BER** is displayed.

(21) Press the ANALYSIS MODE key until CONTINUOUS is displayed.

(22) Verify the condition of the following interface status LED indicators and keys.

(a) RECEIVER MK: ON (illuminated)

(b) RECEIVER SP: ON

(c) RECEIVER SYNC: ON

(d) SYNC LOST: OFF

(e) FRM SYNC: ON

(f) CODE: ON

(g) ALM1: OFF

(h) ALM2: OFF

(i) LOOP UP: OFF

(j) LOOP DOWN: OFF

g. Verify the Fireberd 6000 communications analyzer self loop operation. This is accomplished as follows:

(1) Press the RESTART key to clear the test set.

(2) Press the ERROR INSERT key.

REQUIREMENT: The BIT ERRS display count increases.

(3) Press the RESTART key to clear the test set.

(4) Press the SELF LOOP key to extinguish its LED indicator.

h. Detailed Procedure - Stress Pattern Testing of Type F, FB, DS-1 and DS-1B lines.

(1) Perform the Fireberd 6000 initial set-up as described in steps e, f, and g above.

(2) Connect the interface cable RX bantam plug into the T1/FT1 interface adaptor module INPUT RX jack. Connect the interface cable TX bantam plug into the T1/FT1 interface adaptor module OUTPUT TX jack.

(3) Connect the RX bantam plug on the other end of the interface cable into the DSX cross connect jackfield LINE OUT jack. Connect the TX bantam plug in the other end of the interface cable into the DSX cross connect jackfield LINE IN jack.

(4) Press the MENU key until the SYNTH FREQ is selected.

(5) Use the softkeys and MORE key to select the appropriate data rate of the channel under test.

(6) Press the MENU key to select the INTF SETUP menu.

(7) Press the **T1/FT1** softkey to select the T1/FT1 Data Interface module. The **INTERFACE** display should indicate **T1/FT1**.

(8) Press the **MODE** softkey to select the MODE menu.

(9) Press the appropriate softkey(s) to select the desired operating mode and channels, as required.

(10) Return to the main menu by pressing the

"▲" key on the entry keypad twice.

(11) Press the MENU key until the AUXILIARY category is selected.

(12) Press the **LIST** softkey. Use the **FWD/-RVRS** softkeys to display auxiliary function **41 USER PATTERN.**

(13) Press the **SELECT** softkey. Use the MORE key and softkeys to select the **T1-4** (120 octet) user pattern.

(14) Press the ANALYSIS RESULTS left CATEGORY key to select TIME.

(15) Press the left ANALYSIS RESULTS RESULT key until **ELAP SEC** is displayed.

(16) Press the ANALYSIS RESULTS right CATEGORY key to select PERFORMANCE.

(17) Press the right ANALYSIS RESULTS RESULT key until **AVL SEC** is displayed.

(18) Press the RESTART key to clear the test set.

(19) Monitor the channel for 15 minutes (900 seconds). At the end of the 15 minutes, verify that the **AVL SEC** value equals the **ELAP SEC** value. If **AVL SEC** is less than **ELAP SEC**, the line has failed the test.

(20) Press the ANALYSIS RESULTS right CATEGORY key to select ERROR.

(21) Press the right ANALYSIS RESULTS right key until **BIT ERRS** (bit errors) is displayed.

(22) Verify that no **BIT ERRS** have been recorded in the 15-minute period.

i. If any requirement cannot be met, perform the test a second time. If the test fails a second time, * notify the service provider immediately and begin a 4-hour %EFS test on the line, as described in 93k. *

j. Return all equipment and lines to normal operating status.

97. OPERATIONAL SHADOW TESTING PROCEDURES FOR ALL TYPE LINES.

a. Object. This procedure provides a method of performing operational shadow testing to isolate intermittent problems over a long period of time.

b. Discussion. General procedures for long-term shadow testing of a particular line to isolate intermittent problems, or problems that are difficult to characterize with short-term test, are provided in this paragraph. The procedures can be performed on all line types, where extra data bandwidth is available for performing the test. The procedures do not require service provider participation; however, notification to the provider is encouraged.

c. Test Equipment Required. The following test equipment is identified by generic name. Refer to tables 5-1 and 5-2 for preferred equipment listings. Refer to the appropriate user's guide and operating manual for specifics on test equipment configuration, as necessary.

(1) Digital communications analyzer.

(2) RS-232 or V.35 data interface (depending on data port available).

d. Conditions. This test is performed on an operational circuit, where extra data bandwidth is available, to isolate intermittent problems that cannot otherwise be characterized by short-term tests. The line under test is tested from FAA demarc-to-demarc between facilities. Operational service performance tests for types DDS, F, FB, DS-1, and DS-1B lines are made using the procedures in this paragraph. The procedures do not require service provider participation; however, notification to the provider is encouraged. General test methodology is provided below. Consult equipment reference manuals for exact procedures.

*U.S. GOVERNMENT PRINTING OFFICE:1995-668-016/157

e. Procedure Methodology- Fireberd 6000 and Circuit Connections.

(1) Install the proper interface card in the back of the Fireberd 6000.

(2) Verify operation of the Fireberd 6000 and interface card using the Fireberd's SELF LOOP capability.

(3) Configure the Fireberd for operation with an external printer so that channel operation results are periodically printed. Connect a printer to the Fireberd.

(4) Configure the Fireberd for use on an available channel in an operational circuit as shown in figure 5-3. Connect the Fireberd to the available channel.

(5) Monitor the results of the printout over a period of time long enough to isolate the particular problem.

(6) If the printout shows any out-of-tolerance results, contact the service provider immediately.

98.-110. RESERVED.

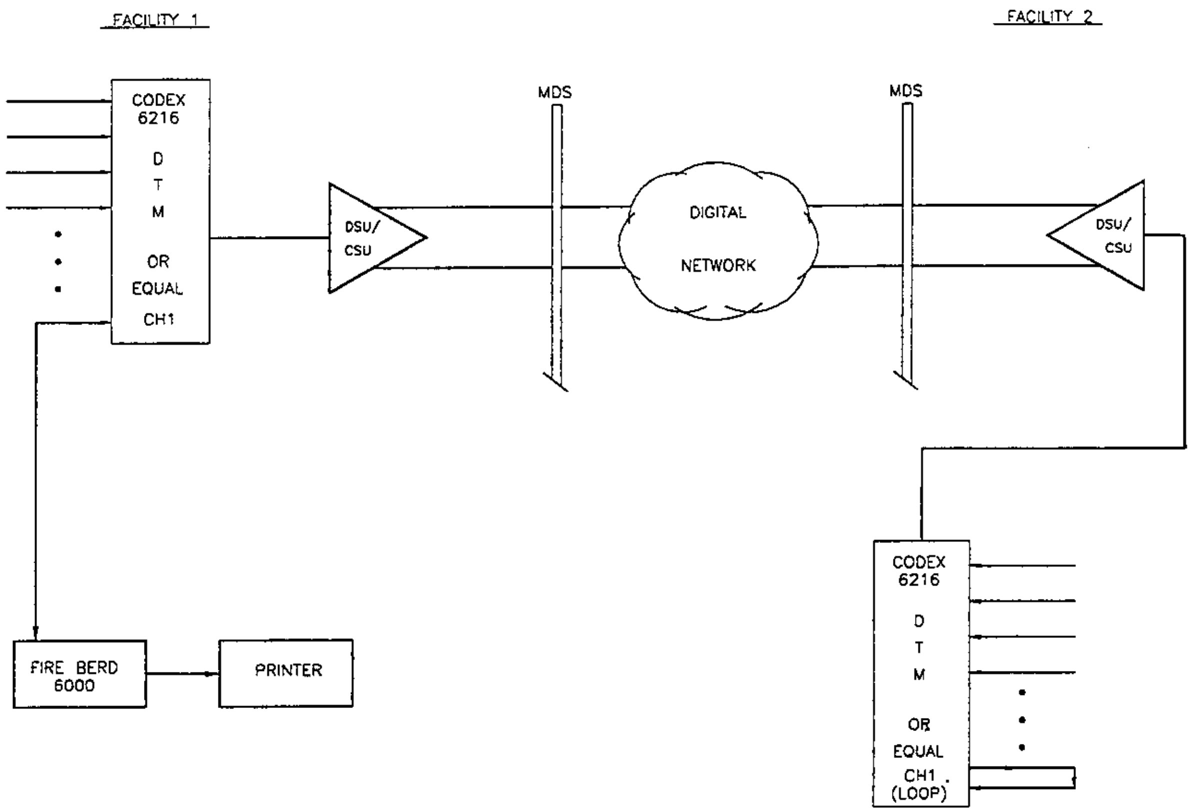


Figure 5-3. Typical Circuit Connections for Performing Operational Shadow Testing

CHAPTER 6. FLIGHT INSPECTION

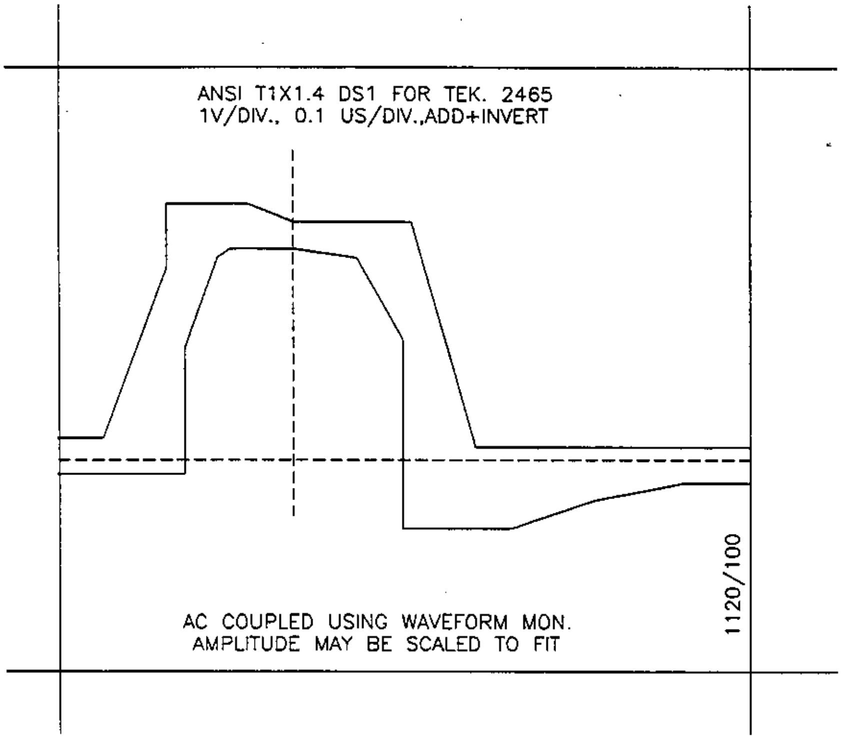
111. GENERAL. Digital transmission channels are not flight checked independently but are an integral part of radar or air/ground communication channels that are flight checked. Refer to the latest version of OAP 8200.1, United States Standard Flight Inspection manual.

112.-120. RESERVED.

CHAPTER 7. MISCELLANEOUS

121. PULSE MASK TRANSPARENCY. A pulse mask transparency, provided as a tear-out in figure 7-1, is to be used with pulse mask measurement test procedures, identified in chapter 5. Cutout either of the two templates along their border; the other template is an extra.

122.-130. RESERVED.



FOR USING TEK 465 AND 2465

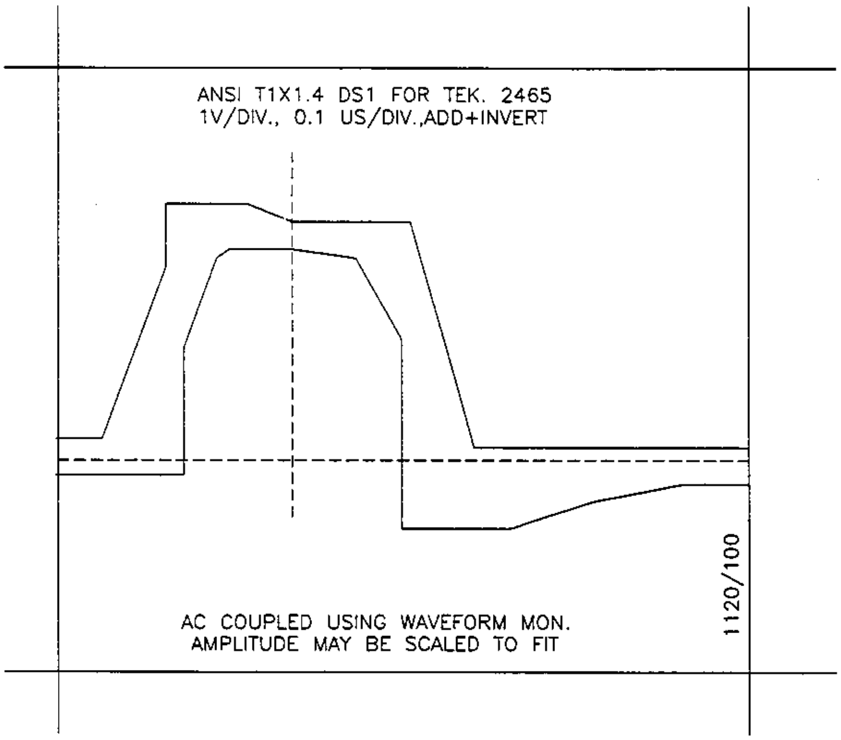


Figure 7-1. Pulse Mask Template

APPENDIX 1. FIREBERD 6000

1. **FIREBERD 6000.** The Fireberd 6000 is an instrument that analyzes the quality of digital communications. It can be used in a variety of locations, including the central office, a technical control center, end-user sites, a engineering laboratories, and an earth station. The Fireberd uses digital interfaces to test T1, G.703, DDS, and synchronous/asynchronous circuits and equipment. In addition to its versatility, the Fireberd combines bit error rate testing with performance, signal, and timing analysis.

a. **Features.**

(1) Multifunctionality. Synchronous and asynchronous testing via built-in RS-232 interface.

(2) CCITT V.35, EIA RS-449, DDS, T1, ISDN, G.703, and G.704 testing via modular interfaces which can be inserted in the Fireberd 6000'S rear panel.

(3) Transmission of standard and non standard clock frequencies from 50 Hz to 15 MHz via a built-in synthesizer.

b. **Test Results.** Complete error analysis, with as many as 50 test results measured simultaneously. Dual displays which show any two test results at the same time.

c. **Data Patterns and Messages.** 17 fixed data patterns: MARK only, 1:1, 1:7, 3-IN-24, six DDS-specific stress patterns, and seven T1-specific stress patterns. Seven pseudorandom data patterns: 63, 511, 2047, 2^{15}-1, 2^{20}-1, 2^{23}-1, and QRSS. Up to three user-programmable patters of up to 2048 bytes each for acceptance testing, stress testing, or simulating live data. Standard FOX message in ASCII-synchronous and four asynchronous character formats: Baudot, BCDIC, ASCII, and EBDCIC.

d. **T1 and G.703 Jitter Analysis.** Generates T1 or G.703/G.704 jitter at a single frequency or automatically sweeps jitter over a range of frequencies. Choose sine, square, ramp, triangle, or external waveform. Wideband jitter measurement accurately determines the amount of T1 or G.703 jitter over a 10 Hz to 40 kHz or a 2 Hz to 100 kHz range, respectively. Jitter spectrum analyzer measures peak-to-peak jitter in 37 discrete frequency bands at 64 kb/s, 40 discrete frequency bands at 1.544 mb/s, and 58 discrete frequency bands at 2048 kb/s. An array of jitter masks permit testing against a variety of standards.

e. **Full Customization and Programmability.** Programs and stores up to 10 commonly used test scenarios. Selectable synchronization loss threshold and response on synchronization loss. Programs and stores three long user patterns of up to 2048 bytes each. Defines in-band and out-of-band flow control.

f. **Operating Modes.** The Fireberd 6000 can be used in these modes of operation:

(1) Emulation of Data Terminal Equipment (DTE), Data Communications Equipment (DCE), and digital transmission test instruments.

(2) Asynchronous timing using the built-in EIA RS-232 interface, the modular CCITT V.35, or the EIA RS-449 data interface.

(3) Synchronous and recovered timing. Recovered timing is interface-dependent.

(4) In-service monitoring of live data or out-of-service testing.

(5) Loopback or end-to-end circuit testing.

(6) Remote control operation via computer.

g. **Digital Interfaces.**

(1) Digital interfaces are the key to the Fireberd 6000's ability to operate in a wide range of telecommunications environments. These interfaces provide the physical connections and signal conversions that allow the instrument to connect, test, and analyze digital

circuits and equipment.

(2) The Fireberd's features and characteristics change based on the current interface selected. Table 1 summarizes the interfaces that are available with the Fireberd 6000.

Table 1. FIREBERD DIGITAL INTERFACES

Model Number	*Manual Number*	*Interface Label*	*Description*
41131[1]	ML11319	DDS	DDS LOCAL LOOP Interface meets requirements for testing Digital Data Service (DDS) equipment connections to the local loop. Tests at rates from 2.4 to 56 kb/s with secondary channel capability.
41440	ML11668	T1/FT1	T1/FT1 Data Interface meets AT&T, Bellcore, and CCITT specifications for T1 (DS-1) 1.544 mb/s and fractional T1.

[1] Fireberd interface model number 41131A is required for 64 kb/s (DDS-64) measurement capability.

APPENDIX 2. LINCS DIGITAL INTERFACE REQUIREMENTS SUMMARY

1. **GENERAL.** This section provides an outline of the technical standards that LINCS digital interfaces are based on, and a brief summary of their technical characteristics. Standards and specifications apply to all FAA demarcation systems, not just the Master Demarcation System (MDS)[1].

a. American National Standards Institute Publications:

(1) ANSI T1.102-1989 Digital Hierarchy - Electrical Interfaces

(2) ANSI T1.107-1988 Digital Hierarchy - Format Specifications

b. AT&T Publications:

(1) PUB 43801 AT&T Reference Digital Channel Bank, Requirements and Objectives, November 1982.

(2) PUB 54016 AT&T Data Communication Technical Reference Requirement for Interfacing Digital Terminal Equipment to Services Employing the Extended Superframe Format, May 1986.

(3) TR 54075, Subrate Data Multiplexing - A Service of DATAPHONE Digital Service, November 1988. DATAPHONE is a registered trademark of AT&T.

(4) PUB 62310 Digital Data System Channel Interface Specification, November 1987.

c. MCI Publications:

(1) MCIT Document 043-240-0001, Circuit Testing Handbook, Volume 2. Addresses test methods and procedures for private line and digital data circuits. Test criteria and limits are specified, as well as the test equipment used.

(2) MCIT Document 045-125-0000, MCI Digital Data Network Specifications and Procedures. This document provides specifications and procedures for implementing MCI's terrestrial Digital Service. Also, included are procedures for establishing high capacity digital (DS-3) trunks for the Digital Data Network.

d. National Fire Protection Association Publications: National Electric Code, 1990. This code covers installations of electric conductors and equipment within buildings, including grounding and bonding procedures and practices. MCI and FAA use this code as a basis for electrical power standards.

2. PERFORMANCE REQUIREMENTS.

a. Technical and interface requirements for all channels:

(1) Accessibility. Each channel is provided on a full period, dedicated basis, for use 24 hours per day, seven days per week.

(2) Channel Delay Time. The maximum delay time across any channel, EUL to EUL, is 50 milliseconds (ms).

(3) Physical Interfaces. Each channel end is terminated at FAA provided demarcation panel or demarcation point located at the specified end-user location (EUL).

(4) Full Duplex Operation. All channels operate in a full duplex mode.

[1]The MDS and other demarcation systems used in the FAA for digital transmission can be considered the main distribution frame for signal connection.

b. Technical and Interface Requirements for DDS Channel Types. DDS channels perform at Master Demarcation System (MDS) in accordance with the technical and interface requirements specified herein.

(1) Type DDS channels are provided at various speeds for point-to-point service. The speed of the channels refers to the Customer Primary Channel Data Rates (identified in AT&T PUB 62310) and as indicated by the type suffix; for example, type DDS-4.8 indicates a data rate of 4.8 kb/s.

(2) Type DDS channels conform to the requirements of AT&T PUB 62310, except as otherwise specified.

(3) Type DDS channels provide a minimum of 99.96 percent error free seconds for any 24 hour period. When the percentage of error free seconds in any 24 hour period falls below this minimum value, the channel is designated as unavailable and restoration processes commence. An unavailable channel is redesignated as available when two (2) hours of data have been processed and the percentage of error free seconds has returned to normal.

(4) Synchronization. Synchronization between LINCS and the FAA equipment is in accordance with the requirements of Bellcore TA-NPL-000436.

(5) Digital Signal Format. Type DDS channels meet the formatting requirements of AT&T PUB 62310.

(6) LINCS provides secondary channel feature for DDS channel types. The secondary channel is in accordance with AT&T PUB 62310.

(7) The DDS channels provides line coding in accordance with AT&T PUB 62310.

c. Technical and Interface Requirements for Type F Channels. Type F channels perform at MDS in accordance with the technical and interface requirements specified herein. Type F channels have performance characteristics of DS-1, except that a fewer number of DS-0 channels are available. LINCS provides the number of channels which, when summed, have a bit rate in kb/s which is equal to the suffix following the "F" of the type designator. The type F channels conform to industry standards for "fractional T1" services.

d. Technical and Interface Requirements for Type FB Channels. Type FB channels perform at the MDS in accordance with the technical and interface requirements specified herein. Type FB channels have performance characteristics of DS-1B, except that a smaller bandwidth is available. LINCS provides type FB channels to have a bandwidth in kb/s equal to the suffix following the "FB" of the type designator. The type FB channels conform to industry standards for "fractional T1" services in other respects.

e. Technical and Interface Requirements for DS-1 Channel Types. DS-1 channels perform at the MDS in accordance with the technical and interface requirements specified herein.

(1) Type DS-1 channels are provided at a speed of 1.544 mb/s, in a channelized (multiplexed) format yielding 24, clear channel, DS-0 signals.

(2) Type DS-1 channels conform to the requirements of ANSI T1.102-1989, except as otherwise specified.

(3) Type DS-1 channels provide a minimum of 99.9 percent error free seconds for any 24 hour period. When the percentage of error free seconds in any 24 hour period falls below this minimum value, the channel is designated unavailable, and restoration processes commence. An unavailable channel is redesignated as available when two (2) hours of data have been processed and the percentage of error free seconds has returned to normal.

(4) Synchronization. Once transmission commences, the transmitter and receiver must maintain synchronization for the duration of the session. This is required for the receiver to recognize which is the first bit of a character, for example. Synchronization may be maintained by clock circuitry or by timing information inserted into the message. Synchronization between LINCS and FAA equipment is in accor-

dance with the requirements of Bellcore TA-NPL-000436.

(5) Digital Signal Framing. The type DS-1 digital signal meets the requirements of the extended superframe (ESF) format per ANSI T1.107-1988. Twenty-four (24), type DS-0 clear channels of 64 kb/s each compose one type DS-1 channel.

(6) Type DS-1 channels provides clear channel capability using Bipolar with Eight-Zero Substitution (B8ZS) line coding in accordance with ANSI T1.102-1989. DS-0 signals are not constrained by ones density and number of consecutive zeros.

f. Technical and Interface Requirements for Specific DS-1B Channel Types. DS-1B channels perform at the MDS in accordance with the technical and interface requirements specified herein. Type DS-1B channels are provided at a bit rate of 1.544 mb/s. Type DS-1B channels transport bulk (unchannelized) signals which are delivered intact to the receiving EUL. Type DS-1B channels meet the performance characteristics of the type DS-1 channels.

g. Technical and Interface Requirements for Specific DS-3 Channel Types. DS-3 channels perform at the MDS in accordance with the technical and interface requirements specified herein.

(1) Type DS-3 channels are provided at a speed of 44.736 mb/s, in a channelized, synchronous DS-3 M13 multiplexed format yielding 28, clear channel, DS-1 and/or 1B signals.

(2) Type DS-3 channels conform to the requirements of ANSI T1.102-1989, except as otherwise specified.

(3) Type DS-3 channels provide a minimum of 97.1 percent error free seconds for any 24 hour period. When the percentage of error free seconds in any 24 hour period falls below this minimum value, the channel is designated unavailable, and restoration processes commence. An unavailable channel is redesignated as available when two (2) hours of data have been processed and the percentage of error free seconds has been returned to normal.

(4) Synchronization. Synchronization between LINCS and FAA equipment is in accordance with the requirements of Bellcore TA-NPL-000436.

(5) Digital Signal Format. The type DS-3 channels meet the requirements for the SYNTRAN format of ANSI T1.107-1988. Twenty-eight (28), type DS-1 and/or 1B extended superframe (ESF) channels compose one type DS-3 channel.

(6) Line Coding. Type DS-3 channels use Bipolar with Three-Zero Substitution (B3ZS) line coding in accordance with ANSI T1.102-1989.

APPENDIX 3. DIGITAL INTERFACE FOR MASTER DEMARCATION SYSTEM

1. GENERAL. This appendix describes the background, purpose, composition and ordering of the digital circuit interface for the Master Demarcation System (MDS). The ADC Telecommunications DSX-DR-SC (DSX-1) is the specified interface for digital circuit termination on the MDS.

a. Background. The divestiture of the Bell system mandated that a Network Interface Point (NIP) be established between customer premise equipment (CPE) and transmission lines. It also became necessary for the FAA to determine the exact location, nature and source of problems relating to transmission. Problems with increased outage times and difficulty identifying the company responsibility for the outage led to the creation of the FAA's MDS.

b. Objective Of The Master Demarcation System.

(1) The MDS was designed to provide a physical point of separation between site CPE and the service contractors' communications circuits entering and leaving a facility. The MDS provides test access and monitoring capability for all terminated circuits.

(2) The goal and objective of the MDS is to provide a well defined point of circuit separation between the contractor's NIP and the site CPE for all interfacility communications paths.

(3) The existing MDS was designed for analog circuit termination. The digital interface is required to match terminal impedance differences, and to reduce potential problems of electromagnetic interference (EMI) and crosstalk. Terminal impedance differ between the analog MDS and digital circuits. Circuits terminating on the analog MDS have a typical value of 600 ohms, whereas, 75 to 100 ohms is the preferred impedance for transmitting high speed digital signals.

(4) Electromagnetic Interference (EMI) and crosstalk represent significant technical barriers to digital termination on the analog MDS. EMI can be a problem when transmitting at higher rates through the analog MDS, and special consideration must be given to shielding, grounding, and conductor separation.

c. Digital Interface (DSX-1) For The MDS.

(1) The digital interface for the MDS, model DSX-DR-SC, has 56 wire wrap terminations and is 23 inches wide. As a rule, two DSX-DR-SCs will be installed on the existing analog jackpanel frame. Wire wrapped connections are made on rear input/output terminations and front cross-connects.

(2) The interface establishes a digital section of the MDS and eliminates the mixing of analog and digital circuits on the MDS. Colored LED's differentiate the 56 kbps (red LED) and T-1 (orange LED) DSX-1 connection. The DSX-DR-SC's LED's are powered by a -48 volt power source.

(3) The DSX-1 terminates high-speed digital services on the MDS, as a part of the National Airspace System (NAS) communications plan. The DSX-1 interface is a recognized digital interface standard. It is designed to be transparent in the digital telephony system and provides a centralized cross-connect and temporary jack access for digital signals.

(4) Physical and electrical characteristics of the standard T-1 cross connect are set by the DSX-1 interface specification. The DSX-1 assures equal voltage, correct digital pulse shape, and matching line impedance of the signals at the interface. The internal jack circuits provides input and output connections to each digital signal. Internal shielding is incorporated in the designs to maintain a high degree of isolation between digital circuits.

d. Utilization of the DSX-1.

(1) Only digital, 4-wire facilities are terminated on the digital MDS (DSX-1). The DSX-1 interface

terminates 56 kb/s, DS-0 and T-1 circuits.

(2) To understand how the DSX-1 performs the cross-connect and patching functions, it is best to study its key component, the jack, shown in figure 1. Each DSX-1 jack is connected to a specific piece of digital equipment by connecting the OUT pins to the signal exiting the DSX-1 and the IN pins to the signal entering the DSX-1.

e. Composition of the DSX-1.

(1) The DSX-1 is composed of three main assemblies:

(a) Input/Output

(b) Cross-Connect

(c) IN/OUT Jack

(2) The input/output assembly consists of wire-wrap terminals. These connections are located on the rear of the DSX-DR-SC. Each jack provides input and output connections for one piece of equipment.

(3) The cross-connect assembly also consists of wire-wrap terminals. These are located on the front of the DSX-DR-SC. Each cross-connect assembly contains IN, OUT, and tracer lamp connections. Cross-connect jumpers are required to complete line side to equipment side connections. The connections are completed using five-conductor twisted pair wire. Cross-connect terminals or connectors are internally wired to jacks, then to the corresponding input and output terminals on the Input/Output Assembly. These cross-connections are automatically disconnected from the circuit when plugs are inserted directly into the IN and OUT jacks of the jackfield assembly.

(4) The IN/OUT jack assembly consists of bantam jacks for the DSX-DR-SC. The IN/OUT jacks are wired directly to terminals on the Input/-Output Assembly and the cross-connect assembly. They provide for test access and for temporary overriding of permanent cross-connections. Patch cords plugged into these jacks automatically disconnect the permanent corresponding cross-connections and replace them with the cross-connections of the patch cords.

(5) The monitor (MON) jack provides access for monitoring CPE wire-wrapped to the DSX-1 INPUT/OUTPUT assembly, or plugged into the corresponding jackfield assembly OUT jacks. This monitoring is accomplished without interrupting operation of the circuit monitored. The MON jacks also provide ground connection to light the tracer lamps whenever a plug is inserted.

(6) The LED tracer lamps provide easy identification of two pieces of CPE interconnected at the cross-connect assembly. A test or dummy plug inserted into the DSX-DR-SC MON jack causes the tracer lamp located above the MON jack to light. This indicates that an CPE OUT circuit is being monitored or tested. In addition, the tracer lamp above the IN jack for the CPE cross-connected to the OUT circuit being tested lights. These two lighted tracer lamps thereby indicate the CPE IN and OUT circuits that have been cross-connected.

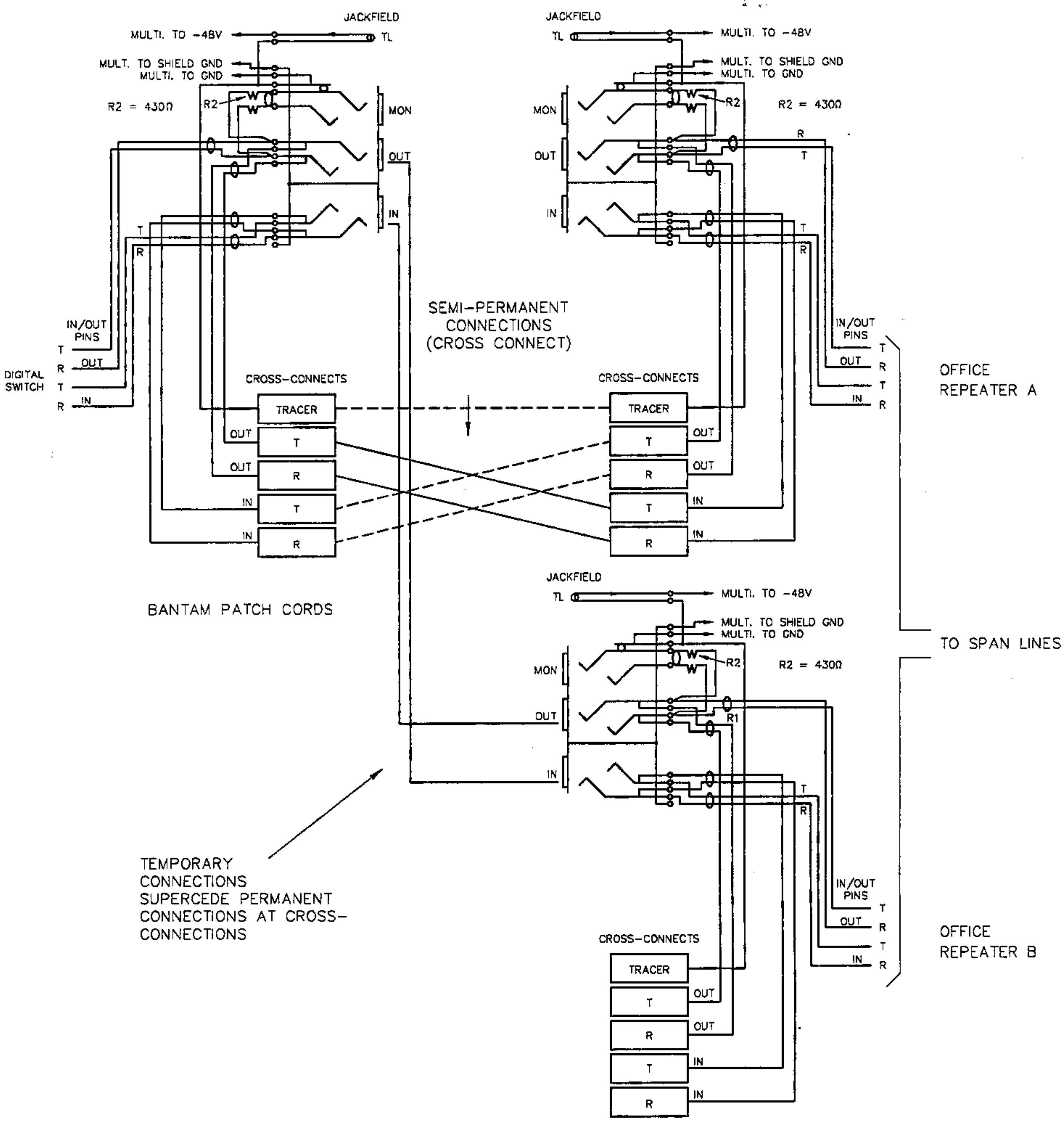


Figure 1. DSX Jack Schematic

f. Ordering Procedure for the DSX-1.

(1) A telecommunications service request must be issued to NAVCOM Systems Incorporated to provide the digital interface and related equipment. Installation of the DSX-1 can be supported by FAA F&E personnel or NAVCOM. CLIN item numbers and optional components for the digital interface and related components are as follows:

Table 1. DSX-1 COMPONENTS

CLIN Item Number	*Quantity*	*Description*
0002-BI	1	DSX-DR-SC with orange LED
0002-BJ	1	DSX-DR-SC with red LED
0005-BS	1	Wire Wrap Gun
Optional ACK-MKB	1	Maintainer Accessory Kit contains Bantam terminating plugs, Bantam dual and single patch cords
Optional DSX-CCW/500	500 feet	Five conductor cable with two twisted pairs and binding wire

GLOSSARY

ACCEPTANCE LIMIT: The maximum value of, or deviation from, a design parameter that is allowed at service turnup or acceptance.

ACK: Acknowledgement, message in a protocol.

ACOUSTIC COUPLER: A device that converts digital signals into audio signals, enabling data to be transmitted over the telephone lines via a conventional telephone.

ACTIVE/PASSIVE DEVICE: A device capable of supplying the current for the loop (active) and a device that must draw its current from connected equipment.

ADDRESS: A unique sequence of letters or numbers for the location of data or the identity of an intelligent device.

ADPCM (ADAPTIVE PULSE CODE MODULATION): A form of voice compression that typically uses 32 kb/s.

ALTERNATE ROUTE: A redundant transmission route which provides the same telecommunications connectivity as the primary route to which it is referenced.

AMI (Alternate Mark Inversion): Line coding for T1 spans.

ANSI: American National Standards Institute; The principle standards development body supported by over 1000 trade organizations, professional societies and companies. USA's member body to ISO (International Standards Organization).

ASCII: American Standard Code for Information Interchange; A seven-bit-plus parity code established by ANSI to achieve compatibility between data services.

ASYNCHRONOUS TRANSMISSION: Transmission is controlled by start and stop bits at the beginning and end of each character.

AUTOMATIC: A capability which results in an action being initiated within the network without human intervention.

AWG: American Wire Gauge, conventional designator of wire size.

B3ZS: Binary 3 zero substitution or bipolar with three zero substitution, line encoding technique used for DS-3 transmission channels.

B8ZS: Binary 8 zero substitution, a technique used to accommodate the ones density requirements of digital T-carrier facilities in the public network, while allowing 64 kb/s clear data per channel. Rather than inserting a one for every seven consecutive zeroes (see ones density), B8ZS inserts two violations of the bipolar line encoding technique used for digital transmission links.

BACKBONE: The part of the Leased System composed of all the nodes and all the interconnecting paths.

BACKBONE NETWORK: A transmission facility designed to interconnect lower-speed distribution channels or clusters of dispersed user devices.

BANDWIDTH: The range of frequencies available for signalling; the difference expressed in Hertz between the highest and lowest frequencies of a band. Often used in digital transmission terminology to indicate the speed at which a given network topology, channel or communication line operates.

BAUD: Unit of signalling speed. The speed in baud is the number of discrete conditions or events per second.

BELLCORE: Bell Communications Research; organized established by the AT&T divestiture, representing and funded by the Bell Operating Company (BOC) and Regional Bell Operating Company (RBOC) for the purpose of establishing telephone-network standard and interfaces; includes much of what had been Bell Laboratories.

BERT: Bit error rate test, or tester.

BIPOLAR VIOLATION (BPV): Two pulses of the same polarity in a row.

BISYNCHRONOUS TRANSMISSION (BSC): A byte or character-oriented IBM communications protocol that has become the industry standard. It uses a defined set of control characters for synchronized transmission of binary coded data between stations in a data communications system.

BIT: Binary digit; the smallest unit of information in a binary system: a 1 or 0 condition.

BIT ERROR: The case where the value of an encoded bit is changed in transmission and interpreted incorrectly by the receiver.

BIT ERRORS: Count of bits whose logical state (0,1) changed along the transmission path. Base measurement for judging circuit quality and availability.

BIT ERROR RATE: Ratio of incorrect bits detected to total bits received. Useful for detecting error bursts over specific bit intervals.

BLOCKING: Isolation of a device from the network while maintaining proper termination characteristics.

BPS or b/s: Bits per second; Unit of data transmission rate.

BUS: A data path shared by many devices (e.g. multipoint line) with one or more conductors for transmitting signals, data or power.

BYTE: A binary element string functioning as a unit. Eight-bit bytes are most common. Also called a character.

CENTRAL OFFICE (CO): The telephone company switching facility or center, usually a Class 5 end-office, at which subscribers' local loops terminate, handles a specific geographic area, identified by the first three digits of the local telephone number. Since divestiture, these facilities are provided by the local exchange company.

CFA (CARRIER FAIL ALARM): Detection of red (local) or yellow (remote) alarm on T1.

CHANNEL: In communications, a physical or logical path allowing the transmission of information; the path connecting a data source and a data "sink" (receiver). Also, an end-to-end connection between and among EUL's. In general, a channel may include a local access segment at each end, and a backbone segment.

CHANNEL BANK: Equipment, typically in a telephone central office, that performs multiplexing of lower speed, generally digital, channels into a higher speed composite channel, the channel bank also detects and transmits signaling information for each channel and transmits framing information so that time slots allocated to each channel can be identified by the receiver. A channel bank can also be located at the customer premises when DS-1 or higher digital service is ordered by the customer.

CLEAR CHANNEL: Characteristic of a transmission path wherein the full bandwidth is available to the user; said primarily of telephone company digital circuits that do not require that some portion of the channel be reserved for carrier framing or control bits.

CLEAR TO SEND (CTS): Signal that indicates to the DTE device to begin transmission.

CLOCK: Timing signals used in synchronous transmission. More generally: the source(s) of timing signals sequencing electronic events.

CONCENTRATOR (STATISTICAL MULTIPLEXOR): A device used to divide a data channel into two or more channels of lower average speed, dynamically allocating channel space according to demand in order to maximize throughput.

CONSECUTIVE SEVERELY ERRORED SECOND (CSES) EVENT: For the digital service, a CSES event shall be deemed to have occurred when a period of five (5) severely errored seconds have occurred consecutively.

COPPER FACILITY: Any wire based transmission medium utilizing copper.

CPE (CUSTOMER PREMISE EQUIPMENT): Hardware located on the FAA's premise.

CROSSTALK: The unwanted transmission of a signal on a channel that interfaces with another channel.

CUTOVER: The connection and activation of an operational signal source (e.g., a radar) from one transmission system to another.

CYCLIC REDUNDANCY CHECK (CRC): A basic error-detection mechanism for link-level data transmission; a characteristic link-level feature of (typically) bit-oriented data communications protocols, wherein the data integrity of a received frame, or a packet, is checked by the use of a polynomial algorithm based on the content of the frame and then matched with the result that is performed by the sender and included in a (most often 16-bit) field appended to the frame.

CHANNEL SERVICE UNIT (CSU): A component of customer premises equipment (CPE) used to terminate a digital circuit, such DDS or T1, at the customer site; performs certain line conditioning functions, ensures network compliance per FCC rules, and responds to loopback commands from the central office: also, ensures proper ones density in transmitted bit stream and performs bipolar-violation correction (also see DSU).

D4 FRAMING: T1 12-frame format in which the 193rd bit is used for framing and signaling information; ESF is an equivalent, but newer, 24 frame technology.

DATA: Digitally represented information, which includes voice, text, facsimile, and video.

DATA CIRCUIT-TERMINATING EQUIPMENT (DCE): Data communications equipment; in a communications link, equipment that is either part of the network, an access point to the network, a network node, or equipment at which a network circuit terminates; in the case of an RS-232-C connection, the modem is usually regarded as DCE, while the user device is DTE, or data terminal equipment; in a CCITT X.25 connection, the network access and packet-switching node is viewed as the DCE.

DATAPHONE: A service and trademark of AT&T; refers to the transmission of data over the telephone network (dataphone digital service or DDS) or to equipment furnished by the telephone company for data transmission.

DIGITAL DATA SERVICE (DDS): Private line digital service offered in both intraLATA by BOC's and interLATA capacity with data rates typically at 2.4, 4.8, 9.6 and 56 kb/s.

DATA SERVICE UNIT (DSU): Component of customer premises equipment (CPE) used to interface to a digital circuit (say, DDS or T1), combined with a channel service unit (CSU), performs conversion of customer's data stream to bipolar format for transmission.

DATA TERMINAL EQUIPMENT (DTE): Generally, user devices, such as terminals and computers, that connect to data circuit terminating equipment (DCE); they either generate or receive the data carried by the network; in RS-232-C connections, designation as either DTE or DCE determines the signaling role in handshaking; in a CCITT X 25 interface, the device or equipment that manages the interface at the user premises; see DCE.

DATA TRANSFER RATE: The average number of bits, characters, or blocks per unit of time transferred from a data source to a data sink.

dB (DECIBEL): The logarithmic unit of signal power ratio commonly used in telephony. It is used to express the relationship between two signal powers, usually between two acoustic, electric, or optical signals; it is equal to ten times the common logarithm of the ratio of the two signal powers expressed in watts. The relative gain or loss of a signal when the measured signal value is compared in a logarithmic ratio to another value.

dBdsx: Decibel referenced to the nominal signal level measured at the dsx jack panel. A DS-1 signal of ±3 volts peak-to-peak into 100 ohms provides 0 dBdsx at the jack panel. Likewise, a typical DDS signal of ±3 volts peak-to-peak into 135 ohms provides 0 dBdsx at the jack panel.

<u>dBm</u>: Decibel referenced to one milliwatt; relative strength of a signal, calculated in decibels, when the signal is compared in a ratio to a value of one milliwatt; used mainly in telephony to refer to relative strength of a signal (e.g. at 0 dBm, a signal delivers 1 milliwatt to a line load, while at -30 dBm a signal delivers .001 milliwatt to a load).

<u>DDS-I, DDS-II</u>: Digital data service type I and digital data service type II. An all-digital transmission facility operating at a primary channel rate of 56 kb/s on DDS-I, and at 72 kb/s with both primary and secondary channels on DDS-II.

<u>DDS-SC</u>: Dataphone digital service with secondary channel (also often referred to as DDS-II); a tariffed private-line service offered by AT&T and certain BOC's that allows 64 kb/s clear channel data with a secondary channel that provides end to end supervisory, diagnostic, and control functions.

<u>DECIBEL (dB)</u>: See dB.

<u>DELAY TIME, END-TO-END</u>: The time to traverse the Leased System from one end user location to another including processing, queuing, connecting, transmission/retransmission and propagation delays. Measure of round trip transmission delay. Useful for detecting possible cause of protocol timeouts.

<u>DEMARCATION POINT</u>: The point defined under the terms of AT&T divestiture that marks the end of a customer's premises and the beginning of the public network.

<u>DEMODULATION</u>: The process of retrieving digital (computer) data from a modulated analog (telephone) signal.

<u>DEVIATION</u>: The departure from a standard or specified value.

<u>D/I</u>: Drop and insert, a multiplex function or type. See also Drop and Insert.

<u>DIGITAL</u>: Referring to communications procedures, techniques, and equipment by which information is encoded as either a binary "1" or "0"; the representation of information is discrete binary form, discontinuous in time, as opposed to the analog representation of information in variable, but continuous, waveforms.

<u>DIGITAL BRIDGE</u>: Allows the connection of subchannel devices (either DCE or DTE) to a single main channel.

<u>DIGITAL DATA</u>: Information transmitted in a coded form (from a computer) represented by discrete signal elements.

<u>DIGROUP</u>: A digital group or when twenty-four voiceband analog channels are combined or multiplexed to form a DS-1 signal.

<u>DIVERSITY</u>: A physical and electrical separation in the routing of transmission paths such that a failure at one geographical location will not cause the loss of both paths.

<u>DNIC</u>: Data Network Interface Circuit, 2B+D ISDN U interface.

<u>DoV</u>: Data over Voice, modems combine voice and data on one twisted pair.

<u>DQDB</u>: Distributed Queue Dual Bus; an IEEE 802.6 protocol to access MAN's, typically at 45 mb/s.

<u>DROP AND INSERT</u>: A term applied to a multiplexer that can add data (insert) to a T1 data stream, or act as a terminating node (drop) to other multiplexers connected to it. See also D/I.

<u>DROP CABLE</u>: In local area networks, a cable that connects perpendicularly to the main network cable, or bus, and attaches to data terminal equipment (DTE).

<u>DRY T1</u>: T1 with an unpowered interface.

<u>DS-0</u>: Digital Signal, level 0; 64,000 bits per second,the worldwide standard rate for pulse code modulated (PCM) digitized voice channels.

<u>DS-0A</u>: Digital Signal level 0 with a single rate adapted channel.

<u>DS-0B</u>: Digital Signal level 0 with multiple channels sub-rate multiplexed in DDS format.

DS-1: Digital Signal, level 1; 1.544 mb/s in North America, effectively synonymous with T1.

DS-1C: Two T1's, used mostly by telco's internally.

DS-2: Four T1's, used mostly by telco's internally.

DS-3: Digital Signal, level 3; equivalent of 28 T1 channels, communications access operating at 44.736 mb/s; effectively synonymous with T-3.

DSP: Digital Signal Processor; specialized chip optimized for fast computations.

DSR: Data Set Ready; an RS-232 interface control signal indicating DCE and line ready to receive data.

DSU/CSU: Data service unit/ channel service unit. Provides digital-to-digital modem communications over all-digital transmission facilities.

DSX-1: Digital Signal cross connect, level 1; part of the DS-1 specification. The master demarcation system's (MDS) digital interface for wideband digital circuits up to T1.

DTM: Digital time division multiplexer. Combines several digital input channels in discrete time-slots for transmission over a single channel. Used in conjunction with the DSU/CSU.

DTR: Data Terminal Ready; an RS-232 interface control signal indicating DTE is ready for transmission.

EIA (ELECTRONICS INDUSTRY ASSOCIATION): A standards organization in the USA specializing in the electrical and functional characteristics of interface equipment.

END-USER LOCATION (EUL): A place at which a leased transmission channel is terminated. Service is delivered to a specific demarcation point at the location. Each EUL will be designated by the Government as a type-A location (EUL-A) or a type-B location (EUL-B). See also type-A and type-B locations.

ERROR FREE SECOND (EFS): An EFS is any second of data in which no bit errors are received.

ERRORED SECONDS: Count of seconds in which one or more bit errors occurred. Base measure of circuit quality. An errored second for the extended superframe formatted digital service is a second in which one or more ESF error events have occurred. An errored second for the DS-3 digital service is a second in which a CRC-9 error event, an Out-Of-Frame (OOF) state, or both have occurred. An errored second for the DDS service is a second in which one or more bit errors are received.

ESF ERROR EVENT: An ESF error event is an ESF that contains either a CRC-6 error event, an out-of-frame (OOF) state, or both as stated in AT&T PUB 54016.

EXTENDED SUPERFRAME FORMAT (ESF): An AT&T proposed T1 framing standard that provides frame synchronization, cyclic redundancy checking, and data link bits; frame consist of 24 bits instead of the previous standard 12 bits; the standard allows error information to be stored and retrieved easily, facilitating network performance monitoring and maintenance.

FAA DESIGNATED DEMARCATION POINT: This DEMARC is the physical point interconnecting the Government communications equipment and the Leased System.

FCC: Federal Communications Commission, regulates communications in U.S.

FDDI (FIBER DISTRIBUTED DATA INTERFACE): 100 mb/s fiber optic standard for a LAN or MAN.

FRACTIONAL T1 (FT1): Digital capacity of N x 64 kb/s but usually less than 1/2 a T1. A communications line consisting of some fraction of a standard T1 line. Fractions are allocated in multiples of 64 kb/s. A T1 line can support up to 24 64-kb/s channels.

FRAME: A group of bits sent serially over a communications channel; generally, a logical transmission unit sent between data link layer entities that contains its own control information for addressing and error checking, the basic data transmission unit employed with bit oriented protocols, similar to blocks; also, in video transmission, a set of electron scan lines (usually

525 in the United States) that comprise a television picture.

FRAMING: A control procedure used with multiplexed digital channels, such as T1 carriers, whereby bits are inserted so that the receiver can identify the time slots that are allocated to each subchannel; framing bits may also carry alarm signals indicating specific alarm conditions.

FULL DUPLEX: Transmission in either direction, at the same time.

GOVERNMENT FACILITY: A Government facility is a location owned, operated, leased, or contracted by or for the Government.

HALF DUPLEX: Transmission in either direction, but not at the same time.

HERTZ (Hz): Measurement that distinguishes electromagnetic waveform energy, number of cycles, or complete waves, that pass a reference point per second; measurement of frequency, by which one Hertz equals one cycle per second.

HSS: Hot spare switchover. Switches a spare modem directly online in the event that the primary modem fails.

INTEREXCHANGE CARRIER (IXC): Any corporation engaged for hire in interstate or foreign communication by wire, fiber, or radio between two or more LATA's. This does not preclude carrying intraLATA traffic concurrent with state regulatory approval.

ISDN (INTEGRATED SERVICES DIGITAL NETWORK): A network system that utilizes the same digital communications equipment for all voice, data, fax, and video, and integrating transmission over the same digital line.

JITTER: The slight movement of a transmission signal in time or phase that can introduce errors and loss of synchronization in high-speed synchronous communications; see Phase jitter.

KBITS/s or kb/s: Kilobits per second; standard measure of data rate and transmission capacity.

LDM (LIMITED DISTANCE MODEM): A signal converter which contains and boosts a digital signal so it may be transmitted much further than a standard RS-232 signal.

LED (LIGHT EMITTING DIODE): A semiconductor light source that emits visible light or invisible infrared radiation.

LOCAL ACCESS: The connection between an EUL-B and a node.

LOCAL ACCESS AND TRANSPORT AREA (LATA): One of 161 local telephone serving areas in the United States, generally encompassing the largest standard statistical metropolitan areas; subdivisions established as a result of the Bell divestiture that now distinguish local from long distance service; circuits with both end-points within the LATA (intraLATA) are generally the sole responsibility of the local telephone company, while circuits that cross outside the LATA (interLATA) are passed on to an interexchange carrier.

LOCAL AREA NETWORK (LAN): A data communications system confined to a limited geographical area with moderate to high data rates (100 kb/s to 50 mb/s). The area may consist of a single building, a cluster of buildings or a campus-type arrangement. The network uses some type of switching technology, and does not use common carrier circuits - although it may have gateways or bridges to other public and private networks.

LOCAL EXCHANGE CARRIER (LEC): An organization that provides intraLATA telecommunications services to the public.

LOOPBACK: Diagnostic procedure used for transmission devices. A test message is sent by a device being tested. The test message is then sent back (or looped) to the receive line(s) and compared with the original transmission. Loopback testing may be done locally or conducted remotely, over a communications circuit. Loopback is also called loop-up.

LOOP-UP: See loopback.

M13: Multiplexer between DS-1 and DS-3 levels.

M24: Multiplexer function between 24 DS-0 channels and a T1, a channel bank.

MAIN DISTRIBUTION FRAME: In telephony, a structure where telephone-subscriber lines are terminated; in conjunction with a private branch exchange (PBX), the place where central office telephone lines are connected to on-premises extensions; at a telephone central office, a site where subscriber lines terminate. In the FAA, the main distribution frame is the MDS.

MDS: Master demarcation system. The centralized demarcation system adopted by the FAA that defines physical and electrical requirements of all analog and digital signals entering or leaving a facility. See Main Distribution Frame.

MODEM: Modulator/demodulator; electronic device that enables digital data to be sent over analog transmission facilities.

MODULATION: Modifying some characteristics of a wave form.

MSS: Modem substitution switch. Switches up to two spare modems online in the event that a primary modem fails.

MTBF: Mean Time Between Failures, average for one device.

MTTR: Mean Time To Repair.

MULTIDROP LINE: A single communications channel (typically, a leased telephone circuit) that interconnects many stations, each of which contains terminal devices.

MULTIPLEXING/MULTIPLEXER: The combining of multiple data channels onto a single transmission medium; any process through which a circuit normally dedicated to a single user can be shared by multiple users; typically user data streams are interleaved on a bit or byte basis (time division) or separated by different carrier frequencies (frequency division).

MULTIPOINT LINE: A single communications channel (typically, a leased telephone circuit) to which more than two stations or other device is attached, though only one may transmit at a time upon being polled (see polling); upon selection, one or more devices on such a line may receive transmissions from the master station; also a multidrop line.

NODE: A facility (FAA or vendor) containing switching equipment to route service over two diverse paths or other nodes.

NON-BLOCKING: A capability of the network such that the total number of available transmission paths is equal to the number of ports. Therefore, all ports can have simultaneous access through the network.

NON-RETURN TO ZERO (NRZ): A binary encoding and transmission scheme in which "ones" and "zeros" are represented by opposite and alternating, high and low voltages; wherein there is no return to a reference (zero) voltage between encoded bits.

NYQUIST THEOREM: In communications theory, a formula stating that two samples per cycle is sufficient to characterize a bandlimited analog signal, in other words, the sampling rate must be twice the highest frequency component of the signal (e.g., sampling at 8 Khz for a 4 Khz analog signal).

OCTET: Implies a meaningless mix of bits, not a coherent sample or byte.

ONES DENSITY: The requirement for digital transmission lines in the public switched telephone network that eight consecutive zeros cannot be in a digital data stream; exists because repeaters and clocking devices within the network will lose timing after receiving eight zeros in a row; any number of techniques or algorithms used to insert a one after every seventh-consecutive zero, see
Bit stuffing.

OUT-OF-FRAME STATE (OOF): An OOF state begins when any two of four consecutive frame synchronizing bits received from the network are incorrect. An OOF state ends when reframe occurs.

PAM: Pulse amplitude modulation.

PATH: A digital route between two nodes.

PATTERN SLIPS: Data pattern condition caused by an added or deleted bit to transmitted pattern. Typically indicates circuit equipment or system timing problem.

PARITY BIT: A bit that is set at "0" or "1" in a character to ensure that the total number of 1 bits in the data field is even or odd.

PARITY CHECK: The addition of noninformation bits that make up a transmission block to ensure that the total number of 1's is always either even or odd.

PCM (PULSE CODE MODULATION): Digital transmission technique that involves sampling of an analog information signal at regular time intervals and coding the measured amplitude value into a series of binary values, which are transmitted by modulation of a pulsed or intermittent carrier; a common method of speech digitizing using 8 bit code works or samples and a sampling rate of (typically) 8 Khz.

PERCENT EFS: The percent of error free seconds is the ratio of one-second intervals not containing any bit errors to the total number of seconds in an observation period multiplied by 100. Measure of circuit quality.

PHASE JITTER: In telephony, the measurement, in degrees out of phase, that an analog signal deviates from the referenced phases of the main data-carrying signal; often caused by alternating-current components in a telecommunications network.

POINT OF PRESENCE (POP): A physical location within a LATA established by an IXC for the purpose of obtaining LATA access and LEC-provided access services. POP applies to both switched and dedicated access, although different POP's may be used for different services.

POINT-TO-POINT: Describing a circuit that interconnects two points directly, where there are generally no intermediate processing nodes, computers, or branched circuits, although there could be switching facilities; a type of connection, such as phone-line circuit, that links two, and only two, logical entities, see multipoint line.

POLLING: A means of controlling devices on a multipoint line.

PROTOCOL: A formal set of conventions governing the formatting and timing of message exchange between two communicating systems.

RAM (RANDOM ACCESS MEMORY): Semiconductor read-write volatile memory. Data stored is lost if power is removed.

RS-232: Interface between data terminal equipment and data communications equipment employing serial binary data interchange.

SERIAL TRANSMISSION: The sequential transmission of the bits constituting an entity of data over a data circuit.

SEVERELY ERRORED SECONDS (SES): For the digital service using the ESF format, any second in which 150 or more ESF error events and/or an Out-Of-Frame (OOF) state occurs shall be deemed a Severely Errored Second. For DS-3 service, any second in which 4000 or more CRC-9 error events and/or an Out-Of-Frame (OOF) state occurs shall be deemed a Severely Errored Second. For DDS service, a severely errored second is any second in which the Bit Error Rate (BER) is worse than $1x10^{-3}$.

SITE LEVEL VERIFICATION: This level of verification is performed at the designated site and verifies overall system requirements.

SPAN LINE: Same as channel.

START BIT: In asynchronous transmission, the first bit or element in each character, normally a space, which prepares the receiving equipment for the reception and registration of the character.

STATUS REPORTING: This is the process by which the routing of status information concerning Leased

System failures and repairs are broadcast to all devices which may need the information for message routing and system monitoring and control.

STOP BIT: In asynchronous transmissions, the last transmitted element in each character, which informs the receiver to come to an idle condition before accepting another character.

SUBSYSTEM: A grouping of one or more equipment items that is a relatively independent, identifiable entity.

SUBSYSTEM LEVEL VERIFICATION: This level of verification is usually accomplished at the contractor's facility and will verify subsystem requirements under ambient conditions.

SYNCHRONIZATION LOSS: Test-set condition which indicates loss of synchronization to incoming pattern due to circuit failure or excess bit errors over a specific bit interval.

SYNCHRONOUS OPTICAL NETWORK (SONET): Bellcore-proposed protocol for fiber networks handling DS-3 transmission with some overhead; likely to become an official ANSI standard (T1X1); will be used by the RBOC's with large fiber trunks.

SYNCHRONOUS TRANSMISSION: Transmission in which data bits are sent at a fixed rate, with the transmitter and receiver synchronized. Synchronized transmission eliminates the need fir start and stop bits.

SYSTEM: An operational grouping of the Subsystems that compose the Leased System. This grouping may include the use of emulators and test fixtures to simulate the operational configuration of the Leased System equipment.

SYSTEM LEVEL VERIFICATION: This level of verification is usually accomplished at the contractor's facility and will verify that the network configuration and design will meet the system requirements under controlled electrical, mechanical, and environmental conditions.

T1: AT&T term for a digital carrier facility used to transmit a DS-1 formatted digital signal at 1.544 mb/s.

T3: A T-carrier with an aggregate rate of 44.736 mb/s.

T-CARRIER: A time-division-multiplexed, typically telephone-company-supplied, digital transmission facility, operating at an aggregate data rate of 1.544 mb/s and above.

TARIFF: The formal process whereby services and rates are established by and for communications common carrier; submitted by carriers for government regulatory approval, reviewed, often amended, and then (usually) approved; the published rate for a specific communications service, equipment or facility that constitutes a contract between the user and the communications supplier or carrier.

TELCO: Telephone central office, in most usages, but also a generic abbreviation for telephone company.

TEST: Test is a method of verification wherein performance is measured during or after the controlled application of functional and/or environmental stimuli. Quantitative measurements are analyzed to determine the degree of compliance. The process uses laboratory equipment, procedures, and/or services.

TIME-DIVISION MULTIPLEXING (TDM): Interleaving digital data from many users onto one serial communications links by dividing channel capacity into time slices; two common techniques are bit interleaving and byte (by character) interleaving.

TRANSIENT: An abrupt change in voltage, of short duration.

TRUNK: A dedicated aggregate telephone circuit connecting two switching centers, central office, or data concentration devices.

TURN-UP: Operational verification of a transmission channel after cutover.

TYPE-A LOCATIONS: A type-A location (designated EUL-A) are major, critical facilities requiring diverse telco entrance facilities, high reliability, and high availability (e.g., five 9's). See also end-user location.

TYPE-B LOCATIONS: A type-B location (designated EUL-B) are less critical facilities that do not have the diversity, reliability or availability requirements of an EUL-A. A location that is not designated by the Government as type-A is type-B. See also end-user location.

VOICE FREQUENCY (VF): Describing an analog signal within the range of transmitted speech, from 300 to 3,400 Hz. Any transmission supported by an analog telecommunications circuit.

U.S. Department
of Transportation

Federal Aviation Administration

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From: ______________________________
Signature and Title

Reply to Attn of: ______________________________
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To: Manager, National Airway Systems Engineering Division, AOS-200

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